AN EVALUATION OF THE HARBOR OF SASEBO, JAPAN AS A TYPHOON HAVEN

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THESIS

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by

Dieter Klaus Rudolph

March 1975

Thesis Advisor: G. J. Haltiner

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) An Evaluation of the Harbor of Sasebo, Japan as a Typhoon Haven		5. TYPE OF REPORT & PERIOD COVERED Master's Thesis March 1975
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Dieter Klaus Rudolph		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Environmental Prediction Research Facility Naval Postgraduate School Monterey, California 93940		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Naval Air Systems Command Department of the Navy Washington, D. C. 20361		12. REPORT DATE March 1975
		13. NUMBER OF PAGES
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office) Naval Air Systems Command Department of the Navy Washington, D. C. 20361		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This study is an evaluation of Sasebo Harbor as a typhoon "haven". Characteristics of the harbor discussed include moorings, facilities available, wind and wave action, storm surge and the topographical effects on winds prior to and during the passage of tropical cyclones. Problems to be considered when remaining in port and possible evasion procedures are examined. The tracks of tropical cyclones from 1947-1973 for the western North Pacific were analyzed to determine the probability of threat to the

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harbor. Observations by the author and information obtained in conversations with harbor authorities are utilized in reaching conclusions. The conclusion reached by this study is in full agreement with the previous study by Fleet Weather Facility, Yokosuka (1967), which considered Sasebo Harbor to be a safe typhoon haven for all but the largest of naval ships (CVA, CVS). For these units evasion must commence early since the waters near Sasebo are restricted. To aid commanding officers, an operationally oriented flow diagram is presented which summarizes the locations of the various sections of the text that could be used in decision making.

An Evaluation of the Harbor of
Sasebo, Japan as a Typhoon Haven

by

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Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN METEOROLOGY

from the

NAVAL POSTGRADUATE SCHOOL
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This study is an evaluation of Sasebo Harbor as a typhoon "haven". Characteristics of the harbor discussed include moorings, facilities available, wind and wave action, storm surge and the topographical effects on winds prior to and during the passage of tropical cyclones. Problems to be considered when remaining in port and possible evasion procedures are examined. The tracks of tropical cyclones from 1947-1973 for the western North Pacific were analyzed to determine the probability of threat to the harbor. Observations by the author and information obtained in conversations with harbor authorities are utilized in reaching conclusions. The conclusion reached by this study is in full agreement with the previous study by Fleet Weather Facility, Yokosuka (1967), which considered Sasebo Harbor to be a safe typhoon haven for all but the largest of naval ships (CVA, CVS). For these units evasion must commence early since the waters near Sasebo are restricted. To aid commanding officers, an operationally oriented flow diagram is presented which summarizes the locations of the various sections of the text that could be used in decision making.

ACKNOWLEDGMENTS

The author wishes to acknowledge the following individuals for their contributions to this study: Mr. Daniel Godsoe for his wealth of information on Sasebo Harbor, AG1 Walter Lubiejewsky for preparing the case study on Typhoon Gilda and for obtaining meteorological data, Dr. G. J. Haltiner and Mr. Sam Brand for their helpful suggestions and guidance throughout the writing effort, Professor R. J. Renard, NPS, and CDR J. D. Jarrell, USN, for their comments and critique.

In addition, the assistance of Commander Service Group Three and Commander Fleet Activities, Sasebo, Japan is gratefully acknowledged.

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CONTENTS

1. INTRODUCTION

1.1 BACKGROUND

One of the most destructive weather phenomena a ship may encounter, whether it be in port or at sea, is the tropical cyclone and, in particular, the typhoon. The commanding officer, when faced with an approaching severe tropical cyclone or typhoon, must make the following timely decision: should the ship remain in port, evade at sea, or, if at sea, should the ship seek shelter in a harbor?

For most western North Pacific harbors there is insufficient or inadequately documented evidence as to the degree of shelter which the port affords ships from typhoons. Furthermore, the uncertainty associated with an anticipated typhoon track and intensity makes it difficult to provide reliable estimates of wind and sea conditions to be expected well in advance of a typhoon's passage. Consequently, the prudent mariner has found it advisable to commence evasive action upon the first indication that a typhoon may strike the port in which his ship is berthed. Considering the majority of harbors, this is undoubtedly true. However, it is becoming clear that there are certain harbors where some ships would be safer in port than at sea. Previous studies on the harbors of Hong Kong (Mautner and Brand, 1973), Kaohsiung and Chilung (Keelung) in Taiwan (Brown, 1974) and Subic Bay and Manila in the Republic of the Philippines (Douglass, 1974) have been completed and provide much

information about these harbors. This study evaluates the harbor of Sasebo, Japan as a "Typhoon Haven".

It is not possible to unequivocally declare a certain harbor as "safe" or "unsafe" due to the many variables involved as to ship type, harbor characteristics, ship's position within the harbor, the orientation of the typhoon track relative to the harbor, etc. The less tangible factors which must also be considered are included in the overall "measure of a harbor".

1.2 THE "MEASURE OF A HARBOR"

"The measure of a harbor is the sum total of many individual factors. It is in the extent of its shelter, depth of water at the piers, quantity and condition of its service craft and the efficiency of its port services. It is measured by the experience level of its port services officer. It is in the skill, spirit and will of his crews. It is in the emergency capability of the Ship Repair Facility to make a ship ready for sea. It is the quality of the typhoon warning service and the lead time provided the Senior Officer Present Afloat (SOPA) to make sound command decisions and to the Port Services Officer to carry out smoothly and efficiently his flexible plan of action. Finally, the measure of a harbor is knowledge of that harbor and all that it connotes in the mind of the Senior Officer Present Afloat who, by his decisions, will stamp it as a vital refuge to be taken or as an inanimate limited shelter to refuse as a

harbor for the ships under his charge." (U.S. Fleet Weather Facility, Yokosuka, Japan, 1967)

2. TROPICAL CYCLONES

2.1 DEFINITION AND DEVELOPMENT

A tropical cyclone is a low pressure disturbance whose warm central core extends to relatively high levels in the troposphere. In order for the tropical cyclone to intensify, tremendous amounts of energy are required to develop and sustain the high wind velocities characteristic of severe tropical cylones. Only the warm, moisture-laden air of the tropics possesses this quantity of energy. The area between the latitudes 5-20N and from 170E to the Philippine Islands produces more intense tropical cyclones than any other region in the world.

2.2 CLASSIFICATION

By international agreement, tropical cyclones have been classified according to their maximum sustained winds[1] as follows:

Tropical Depression: Maximum sustained winds do not exceed 33 knots.

Official consecutively numbered warnings are disseminated by the Fleet Weather Central/

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[1]The maximum winds referred to usually occur near the center and near the eye wall. However, strong winds will usually extend a considerable distance outward from the center, particularly in the dangerous semi-circle. In this connection, sustained wind is defined as the average wind over a specified time period, (usually, one-two minutes). The wind will be stronger in gusts, and peak gusts may be 50% higher than the sustained wind.

Joint Typhoon Warning Center/Guam (FWC/JTWC) on tropical depressions which are forecast to become tropical storms within 48 hours. In WESTPAC, FWC/JTWC issues these warnings with immediate precedence at six-hourly intervals.

Tropical Storm: Maximum sustained winds between 34 and 63 knots.

Most of the tropical depressions will intensify into tropical storms. Tropical storms are named in alphabetical order from four consecutive lists of women's names.

Typhoon: Maximum sustained winds in excess of 63 knots.

About two-thirds of the tropical storms intensify to typhoon force. At this stage, the well-known "eye" with relatively calm winds and clear skies will develop at the center. The "eye" is surrounded by a wall of clouds where the strongest winds and heaviest rain are found.

2.3 MOVEMENT

The majority of tropical cyclone tracks conform to a general pattern by initially moving west-northwest from the source region. Steered by the prevailing easterlies, the tropical cyclone moves at speeds from 8 to 14 kt. Normally, upon reaching latitudes between 20-30 N, tropical cyclones

are influenced by the prevailing westerlies and undergo "recurvature". This implies that the west-northwest movement gradually shifts to a northeasterly direction. After recurvature, the tropical cyclone's speed of movement can accelerate within 48 hours to as much as two to three times the speed at the point of recurvature (Burroughs and Brand, 1972). However, in conjunction with the increase in speed of movement, a gradual weakening occurs as the tropical cyclone moves over cooler waters or when cool surface air enters the storm system. Figure 1 summarizes the major characteristics of "recurvers" and their monthly variations.

It is important to keep in mind that the course of individual storms cannot be said to follow any standardized pattern. Numerous typhoons have followed extremely erratic courses, even making occasional loops in their tracks. For this reason, the progress of each typhoon should be closely monitored for changes in intensity, direction and speed of movement. The mean monthly tropical cyclone tracks are presented as Appendix A.

2.4 WIND CIRCULATION AND INTENSITY

The counter-clockwise wind circulation about the eye of a typhoon in the Northern Hemisphere is depicted in Figure 2. Note that in the upper portion of Figure 2, the wind circulation and typhoon speed of movement are in essentially the same direction. This results in winds of great intensity and a high sea state. Ships located in the forward right

quadrant tend to be pushed into the path or center of the typhoon as a result of the circulation pattern. For these reasons, this area is known as the "dangerous" semicircle.

In the lower quadrants, the typhoon direction of movement and wind circulation are opposed. This results in a somewhat calmer sea state and less intense relative winds than in the "dangerous" semicircle. Ships in the lower rear quadrant will be pushed into the wake of the typhoon by the circulation pattern. The lower two quadrants comprise the "navigable" semicircle. The terms "navigable" and "dangerous" are used in a relative sense. The winds and seas are dangerous anywhere near the center of a typhoon.

2.5 SEA STATE

Wave development is a function of wind intensity (the stronger the wind, the more rapid the development and the greater is the maximum height of fully developed waves), wind duration, and the distance (fetch) over which the wind has acted.

Since the strongest winds are found just outside the eye, it is here that the seas develop most rapidly. The swells traveling out ahead of the storm originate in the "dangerous" semicircle while those traveling toward the rear originate in the "navigable" semicircle.

The waves generated near the center usually travel faster than the storm and are often observed well ahead of the typhoon as long, low swells. For this reason, they are

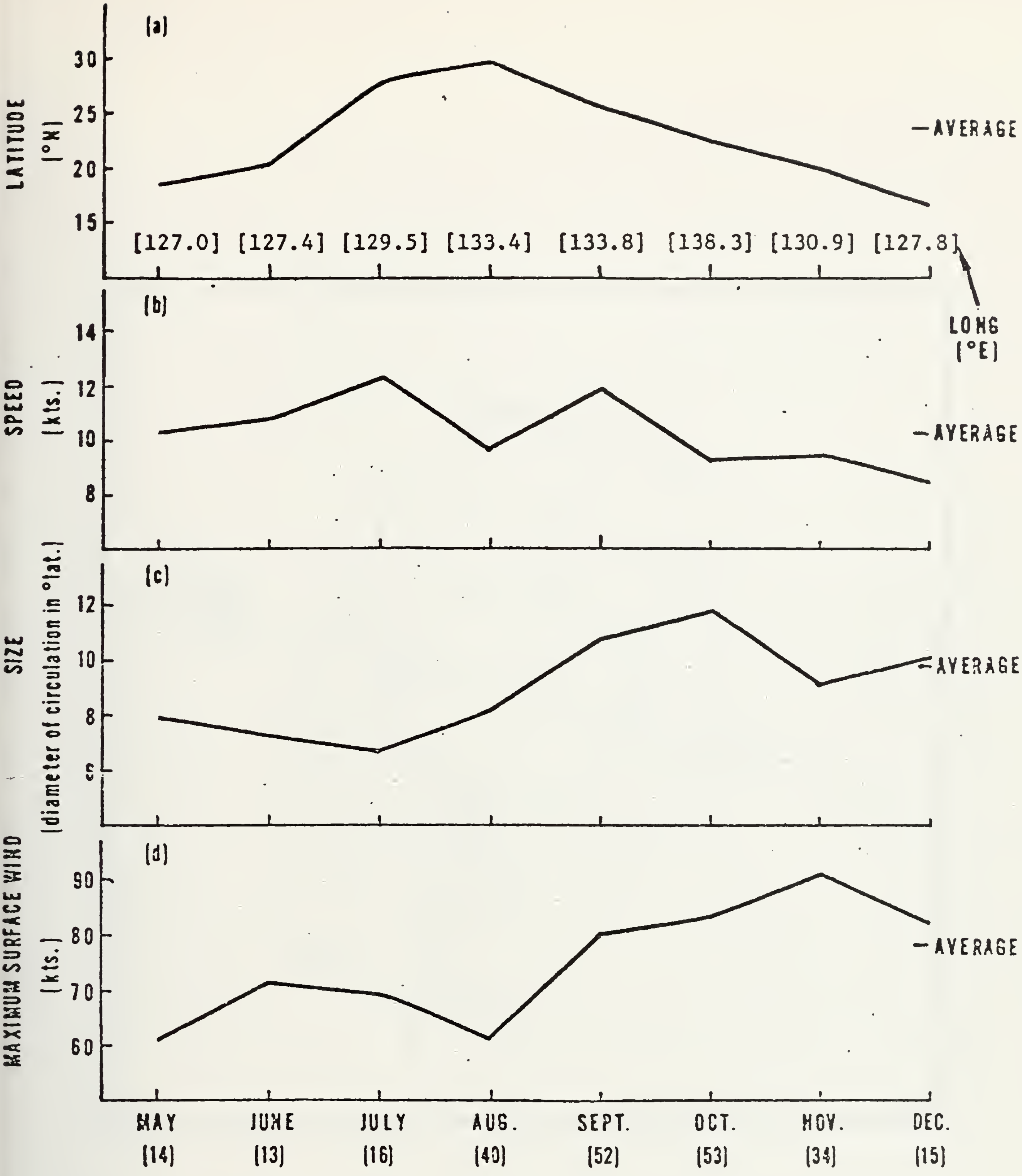


Figure 1. Seasonal variation at point of recurvature of (a) latitude and longitude [in brackets]; (b) speed of movement; (c) size; and (d) maximum surface wind for the recurving tropical storms and typhoons from May - December (1945-1969). The number in parentheses below each month is the number of recurving tropical storms and typhoons observed for each month. The size parameter is the diameter of circulation as deduced from the average diameter of the outer closed surface isobar (Burroughs and Brand, 1972).

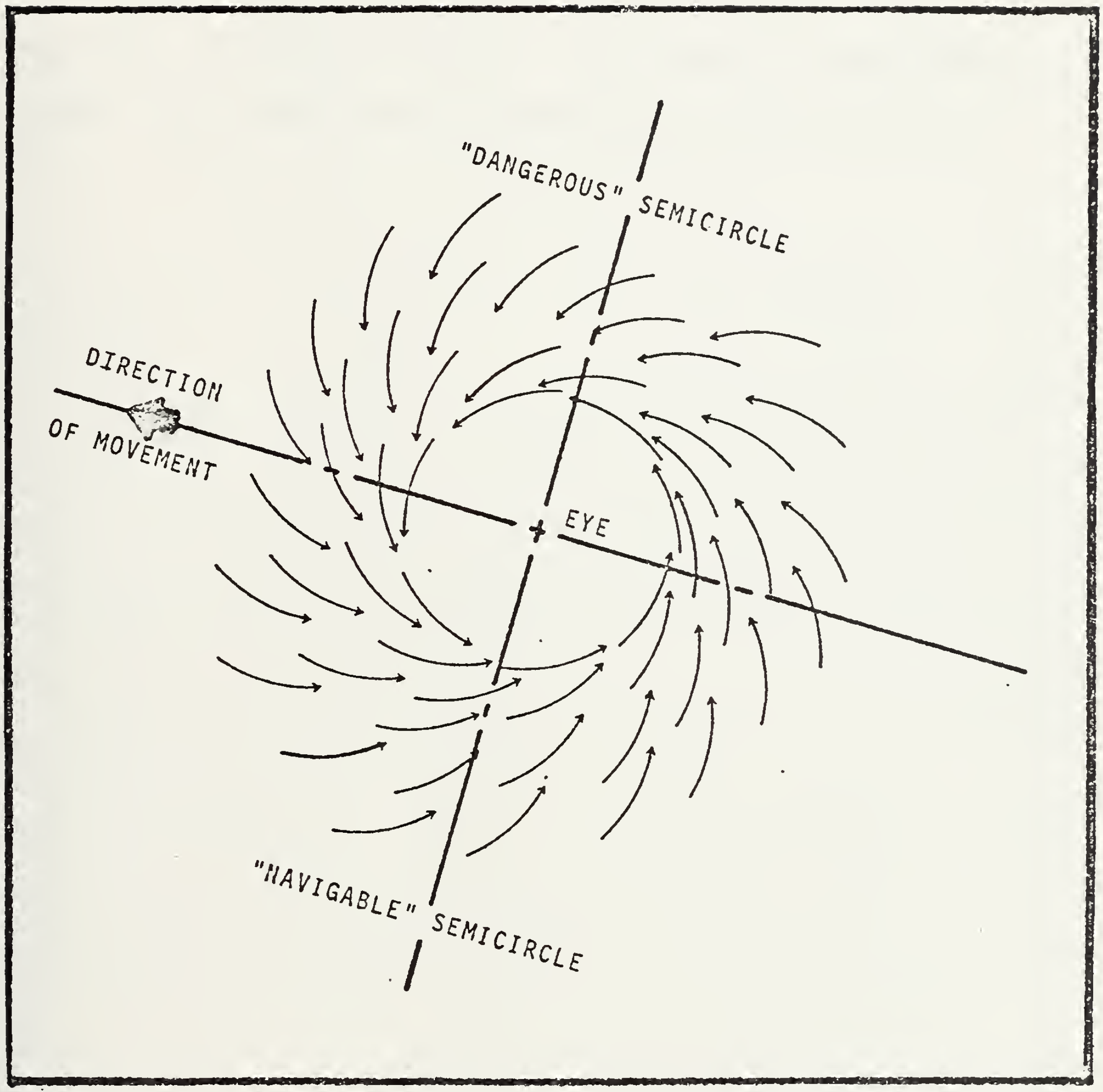


Figure 2. Wind circulation of a tropical cyclone in the Northern Hemisphere indicating the "dangerous" and "navigable" semicircle. (After CINCPACFLT OPORD 201-YR, Annex H).

commonly referred to as "forerunners". It is important to realize that sea conditions affecting ship movement will extend well beyond the wind field associated with a tropical cyclone. A miscalculation concerning sea conditions could result in a destructive rendezvous with the storm.[2]

[2]For further discussion of sea states around tropical cyclones, refer to Brand, Blelloch, and Shertz, 1973: "State of the sea around tropical cyclones in the western North Pacific Ocean."

3. JAPAN

3.1 GEOGRAPHIC LOCATION

Figure 3 shows the position of Japan in the western part of the North Pacific Ocean. The four main islands, Hokkaido, Honshu, Shikoku, and Kyushu are traversed by a series of mountain ranges which run through the islands with relatively small plain areas between the mountains and the surrounding seas.

A detailed study of the coast and harbors of Japan is included in H. O. Pub. 156, Sailing Directions (Enroute) for Japan. For specific comments on navigation aids and coastal features, the reader is referred to this publication.

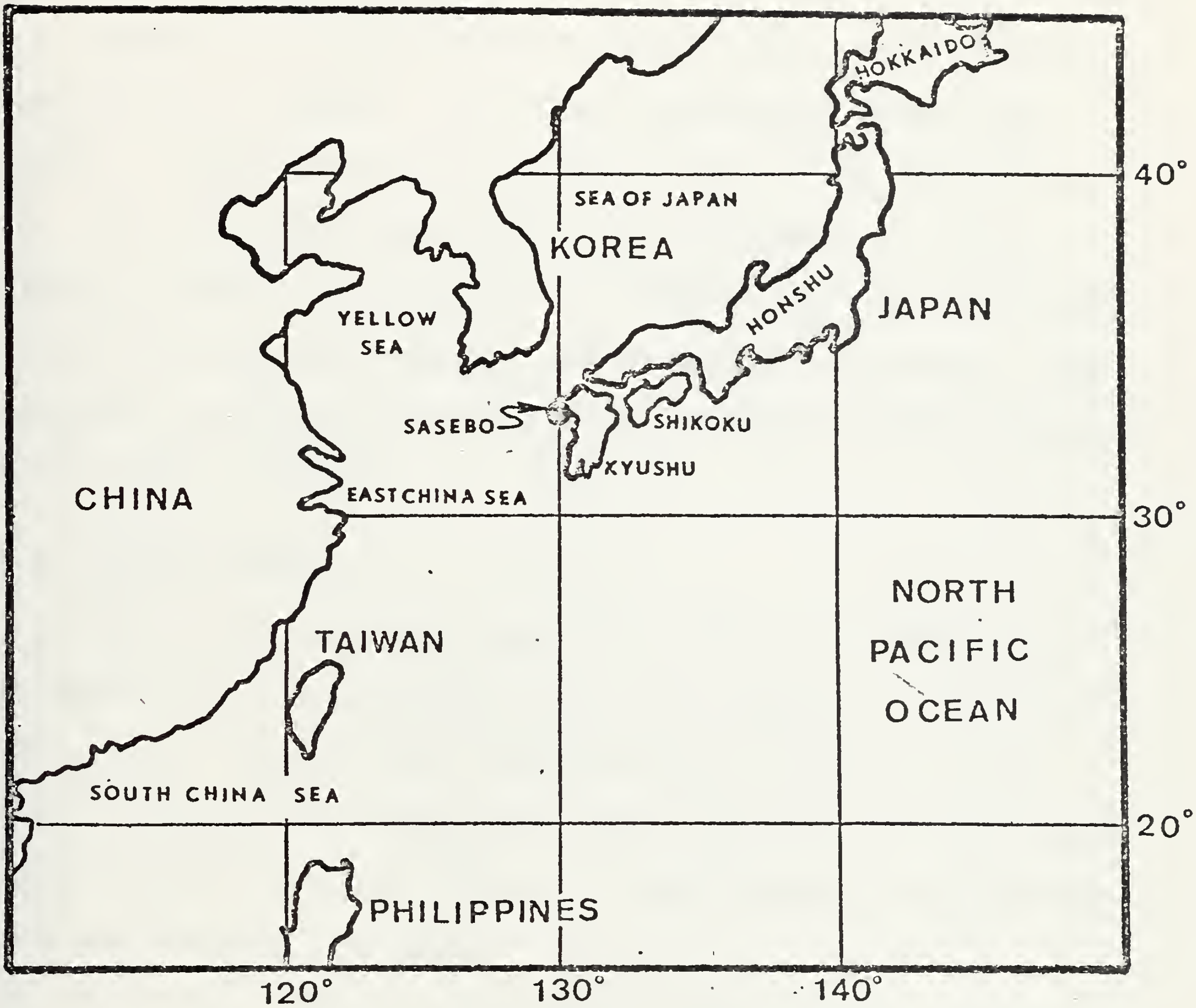


Figure 3. Geographical location of Sasebo.

4. SASEBO - GENERAL DESCRIPTION

4.1 GEOGRAPHICAL LOCATION

Sasebo is located on the southern shore of the northwestern tip of Kyushu. The Kyushu Mountains extend from north to south through the center of the island (See Figure 4). The mesoscale topography of the northwestern tip of Kyushu is depicted in Figure 5. Note the presence of a 1000 -2000 foot mountain range to the northeast of Sasebo. This provides excellent protection from tropical cyclones passing to the east of Sasebo.

4.2 SASEBO HARBOR

The port of Sasebo, located at 33° 10' N, 129° 43' E, is one of the two major Japanese ports frequented by U. S. Navy ships. The port was established as a naval base in 1886. Prior to and during World War II, it was an important repair base and, since the war, it has become a major commercial and shipbuilding port.

The inner harbor of the port is the northern extension of the outer harbor. The channel depth at the main entrance to the bay is over 110 ft, while the channel leading to the inner harbor is over 40 ft deep. The current flows at a maximum speed of 1.5 kt in the vicinity of the harbor entrance during a rising tide. The speed of current is faster during an ebb tide, but the current within the port limits is

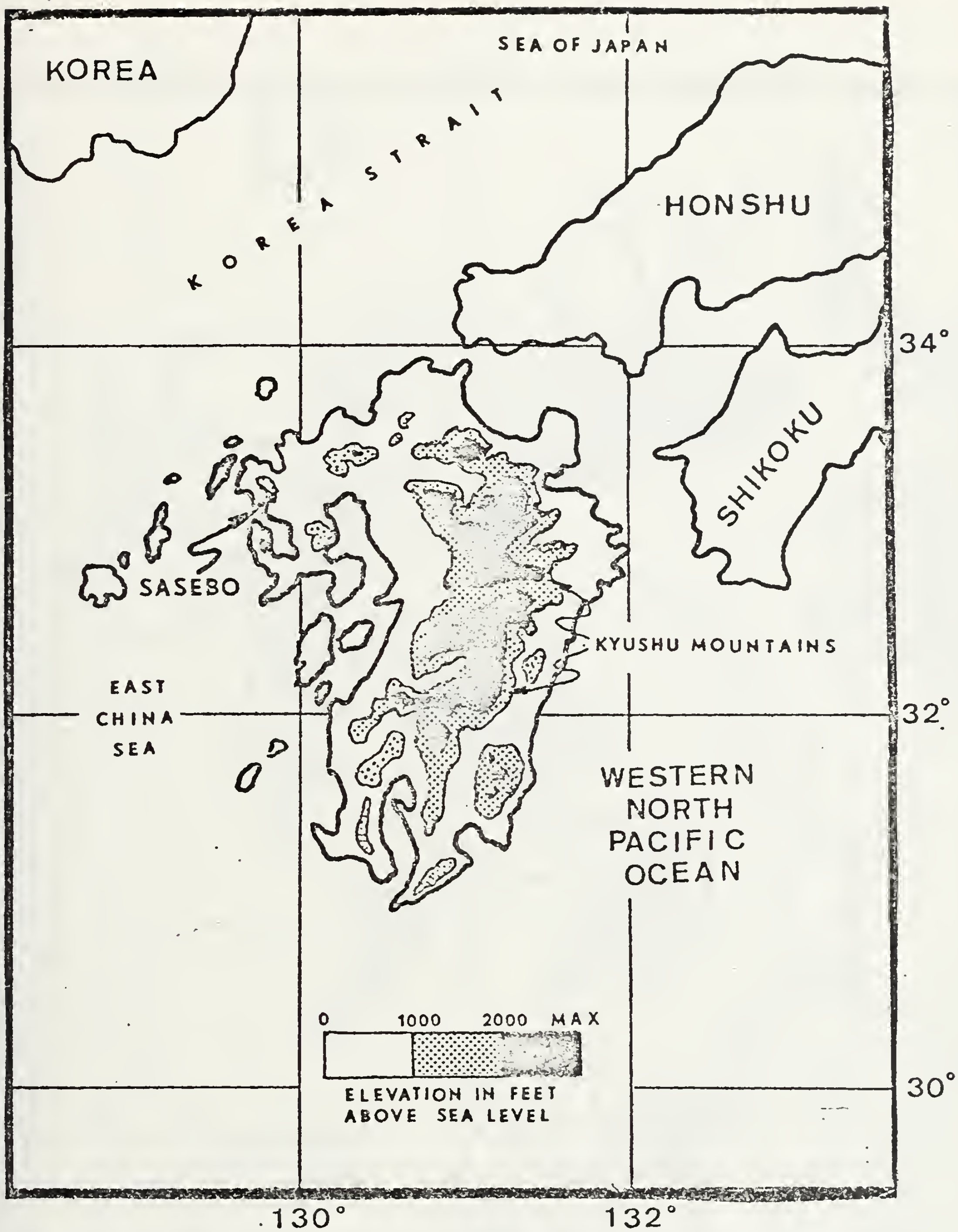


Figure 4. Kyushu topography.

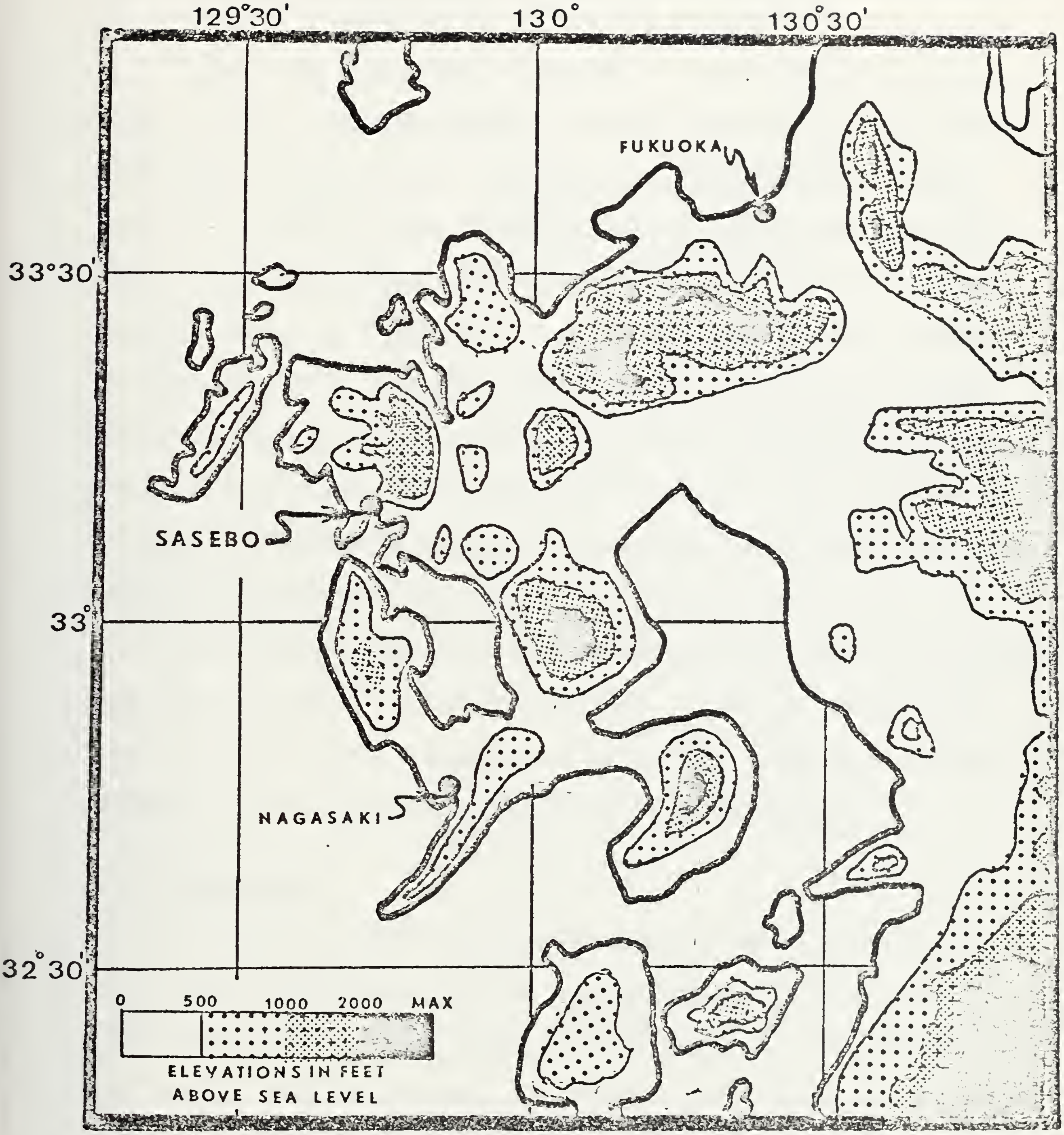


Figure 5. Topography of the northwestern tip of Kyushu.

not so strong as to hinder navigation. There is no record of a tsunami (tidal wave) affecting the harbor.

Figure 6a shows the location of India Basin in the inner harbor where Commander Service Group Three is located and Figure 6b provides a close-up of India Basin. This basin is used by large vessels, while Juliet Basin is utilized by harbor craft. The area between India and Juliet Basins, known as "Tategami" is the resting place of about 15 mothballed LST's. During the passage of a severe typhoon close to Sasebo, these vessels provide a potential danger to other ships since they could break loose. This problem is recognized by the Operations Department of Fleet Activities and the vessels are therefore checked periodically.

The outer harbor provides numerous anchorages in a seabed with excellent holding strength. Typhoon anchorages are located in the vicinity of Ebisu Bay where protection is offered by the surrounding hills of Hario Island.

4.3 TOPOGRAPHY

The outer harbor (Sasebo-Wan) is a large land-locked bay, well protected by hills and mountains on all sides. (See Figure 6). Major peaks to the west rise to 788 ft. To the north, the bay is protected by a 1,253 foot mountain and to the northeast by a 1,864 ft mountain. Along the eastern side of the bay, elevations run from 200 to 604 ft, while to the south of the bay, peaks extend to 331 ft.

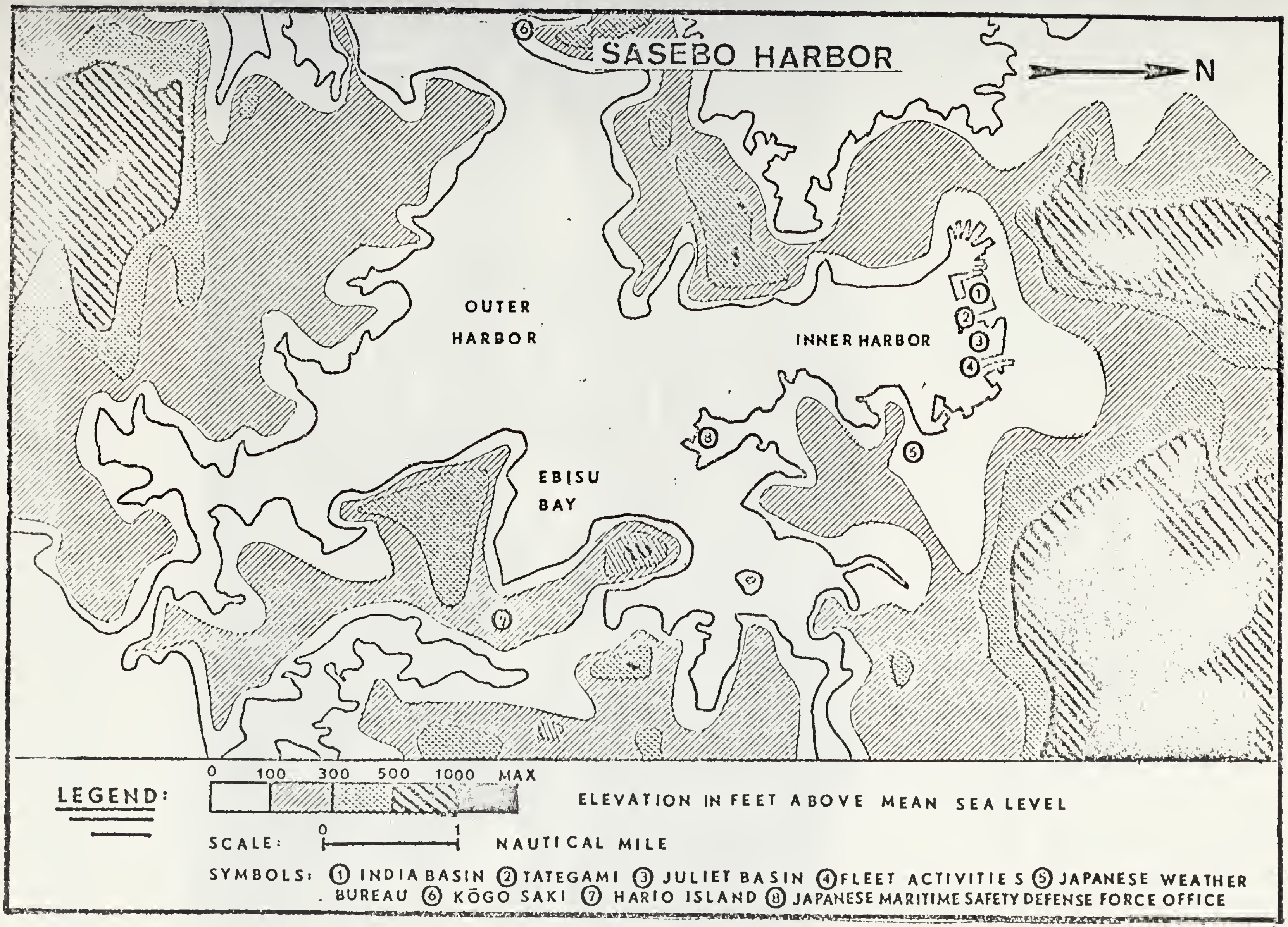


Figure 6a. Sasebo Harbor and surrounding topography.

4.4 HARBOR FACILITIES

India Basin can berth approximately eight large ships alongside. In addition, there are seven fueling piers, numerous mooring buoys with capacities up to 30,000 tons and anchorages available in the bay. Major hull and machinery repair work can also be accomplished. Appendix B gives specifics on the harbor facilities available.

Figure 6b. Close-up view of India Basin located at northern part of Sasebo inner harbor.

5. TROPICAL CYCLONES AFFECTING SASEBO

5.1 CLIMATOLOGY

Climatology indicates that the Island of Kyushu has been affected by tropical cyclones from April through December. However, the majority of the severe tropical cyclones that pose a threat to Sasebo (any tropical cyclone approaching within 180 n mi is considered a "threat") occur during the months of June-October.

Figure 7 gives the monthly summary by five-day periods of "threat" tropical cyclones. Seventy-three tropical cyclones threatened Sasebo during the twenty-six year period, 1947-1973, an average of 2.8 per year. The peak threat period is August, followed by July and September. Sixty-eight percent of the "threat" tropical cyclones had a northeasterly direction of movement prior to their closest point of approach (CPA) to Sasebo and, therefore, can be classified as "recurvers". Figure 7 also indicates that during June and October, 100 percent of the "threat" tropical cyclones were "recurvers", followed by September (87%), August (65%) and July (29%). Since the majority of "threat" tropical cyclones are recurvers, the reader may find it worthwhile to review the characteristics of recurving tropical cyclones (See Figure 1, Section 2.3).

Figure 8 displays the "threat" tropical cyclones according to the compass octant from which they entered the 180 n mi radius threat area. The circled numbers indicate the

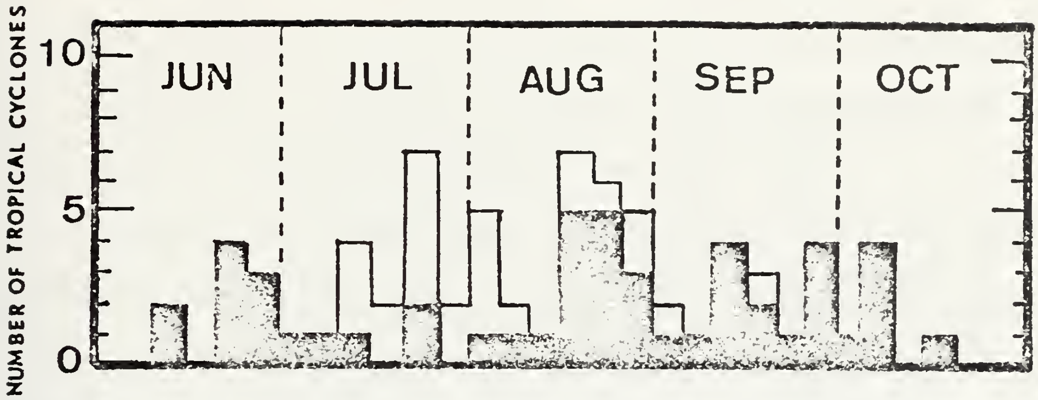


Figure 7. Frequency distribution of the number of tropical cyclones that passed within 180 n mi of Sasebo. Subtotals are based on 5-day periods, for tropical cyclones that occurred during 1947-1973. Shaded area indicates the number of recurving tropical cyclones per 5-day period.

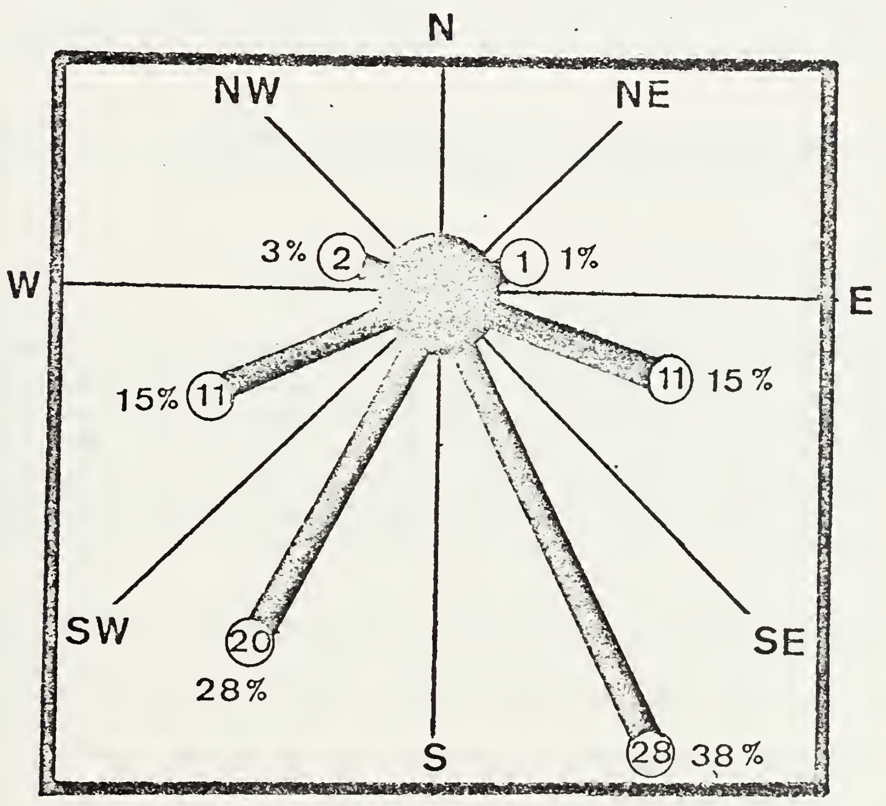


Figure 8. Directions from which tropical cyclones entered threat area (a 180 n mi radius circle centered at Sasebo) during the period, 1947-1953. Numbers circled indicate the number of tropical cyclones that entered from each octant. This is expressed as a percentage adjacent to the circled number.

total that entered from an individual octant. The adjacent numbers express this as a percentage. It is evident that the majority of tropical cyclones (66%) entered the threat area from a sector extending from SW to SE.

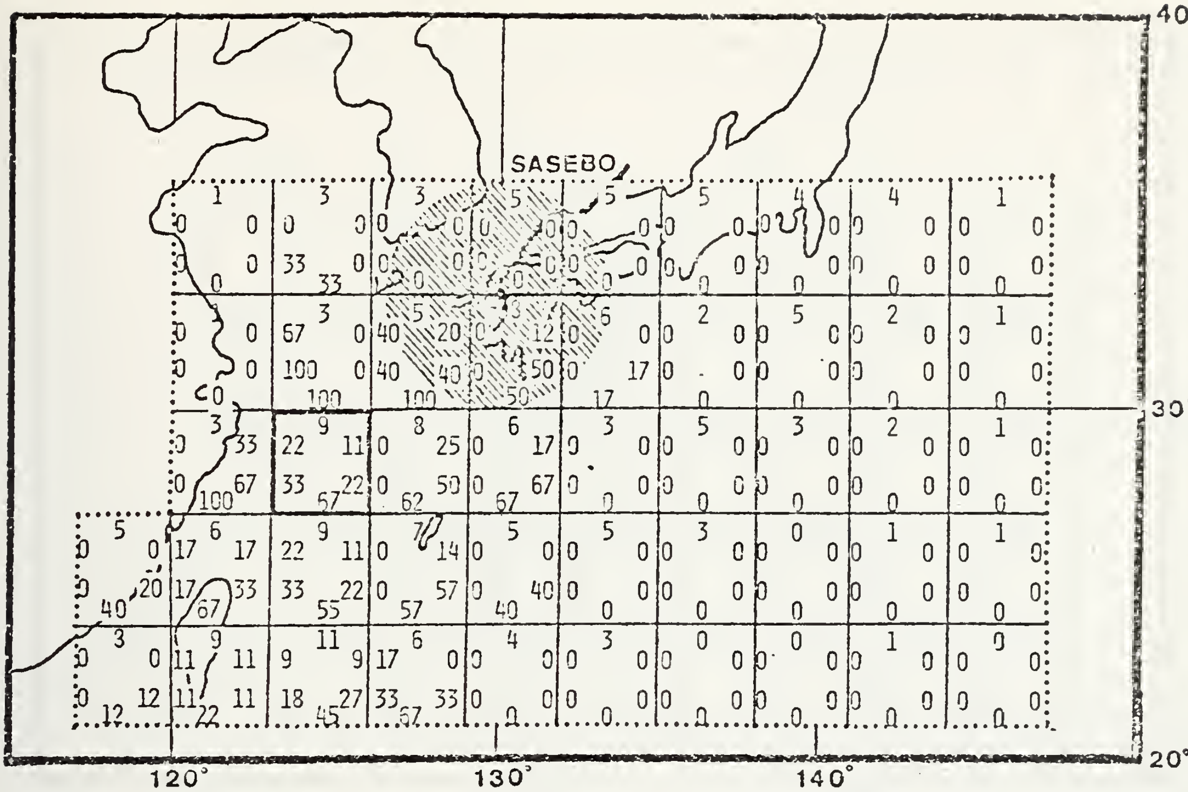
Table 1 indicates that out of the 73 "threat" tropical cyclones during the years 1947-1973, 57 percent passed Sasebo to the east, 37 percent passed Sasebo to the west and 6 percent dissipated southwest of Sasebo. The fact that the majority of "threat" tropical cyclones pass to the east, implies that Sasebo is placed in the left or "navigable" semicircle where the wind and seas are less in intensity.

Table 1. "Threat" tropical cyclones passage relative to Sasebo (1947-1973).

Month	JUN	JUL	AUG	SEP	OCT	TOTAL
Passed east of Sasebo	6	6	14	11	5	42
Passed west of Sasebo	3	8	11	4	1	27
Dissipated without passing	0	3	1	0	0	4

An overall statistical summary of the tropical cyclone climatology for the years 1947-1973 is provided in Figures 9 to 13. This summary is based on tropical cyclone tracks grouped by month,[3] June through October. Since the tracks

[3]From Chin, 1972 for years 1947-1970, and from Annual Typhoon Reports for 1971-1973 (FWC/JTWC).



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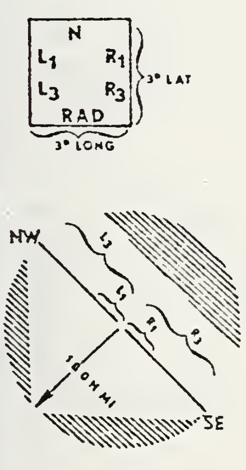


N = NUMBER OF TROPICAL CYCLONES THAT PASSED THROUGH THIS SQUARE FOR THE MONTH

L_1 = PERCENT OF ALL TROPICAL CYCLONES THAT PASSED THROUGH THIS SQUARE AND SUBSEQUENTLY CROSSED A LINE EXTENDING NW FROM SASEBO WITHIN A DISTANCE OF 60 N MI (1° LAT)

L_3 = PERCENT OF ALL TROPICAL CYCLONES THAT PASSED THROUGH THIS SQUARE AND SUBSEQUENTLY CROSSED A LINE EXTENDING NW FROM SASEBO WITHIN A DISTANCE OF 180 N MI (3° LAT)

R_1 = PERCENT OF ALL TROPICAL CYCLONES THAT PASSED THROUGH THIS SQUARE AND SUBSEQUENTLY CROSSED A LINE EXTENDING SE FROM SASEBO WITHIN A DISTANCE OF 60 N MI (1° LAT)

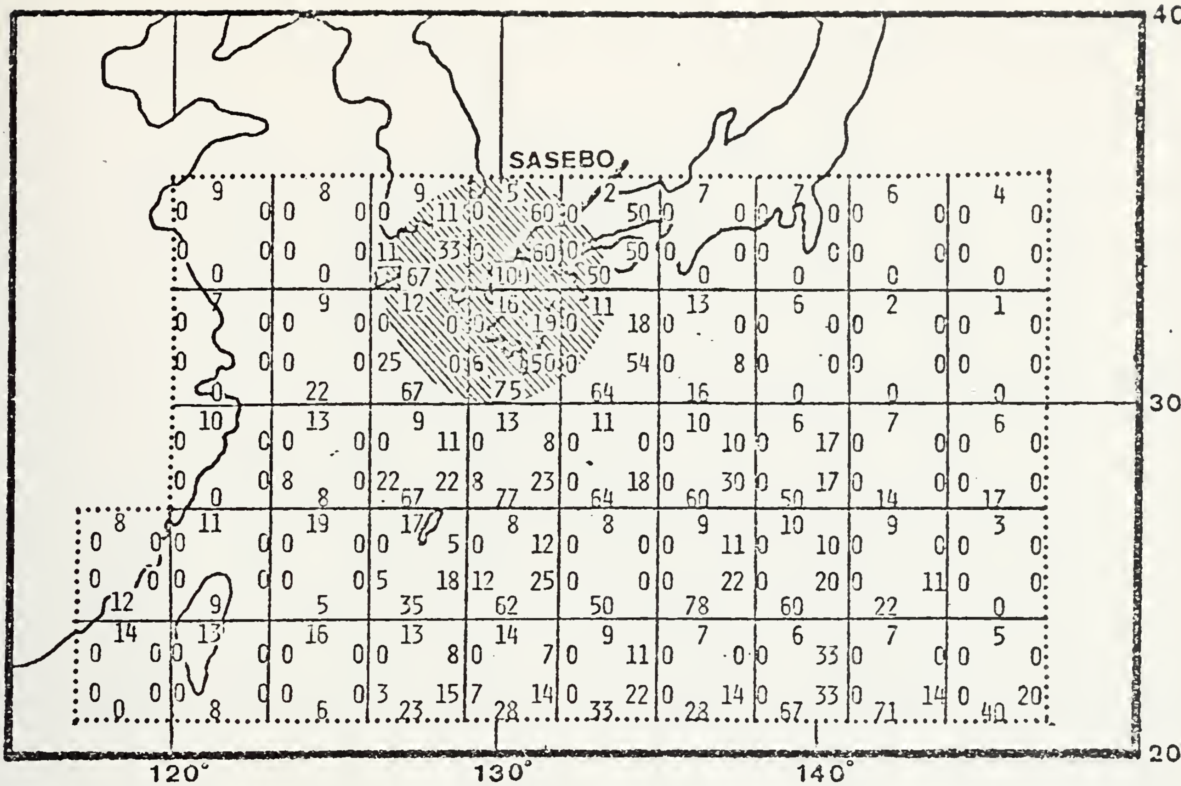
R_3 = PERCENT OF ALL TROPICAL CYCLONES THAT PASSED THROUGH THIS SQUARE AND SUBSEQUENTLY CROSSED A LINE EXTENDING SE FROM SASEBO WITHIN A DISTANCE OF 180 N MI (3° LAT)

RAD = PERCENT OF TROPICAL CYCLONES THAT PASSED THROUGH THE SQUARE AND SUBSEQUENTLY PASSED WITHIN 180 N MI OF SASEBO

FOR THE MONTH OF:

JUN (31 MAY - 29 JUN)

Figure 9. Statistical summary of tropical cyclone tracks that passed within 180 n mi of Sasebo for the month of June. (Based on data from Chin, 1972 and FWC/JTWC Annual Typhoon Reports 1971-1973).



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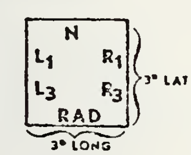

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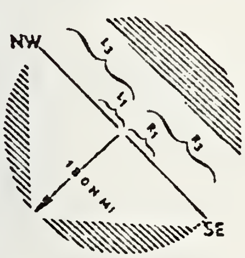
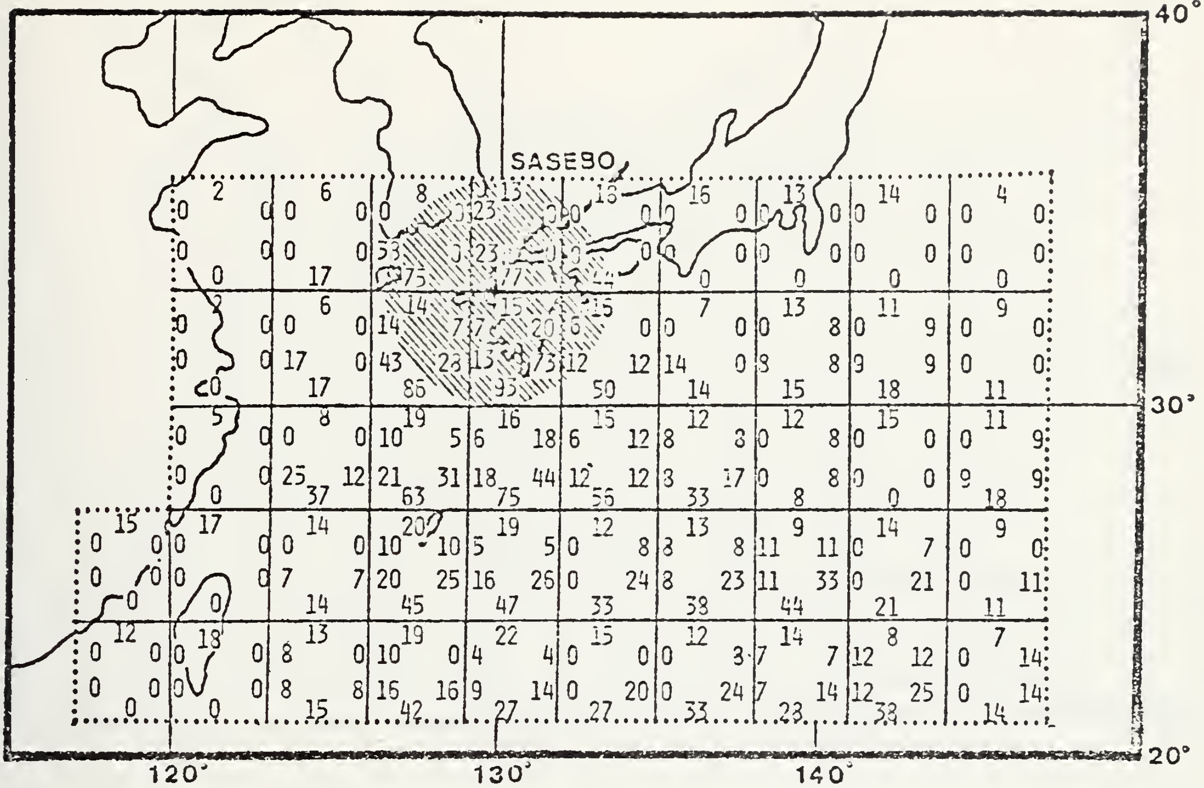
RAD = PERCENT OF TROPICAL CYCLONES THAT PASSED THROUGH THE SQUARE AND SUBSEQUENTLY PASSED WITHIN 180 N MI OF SASEBO



FOR THE MONTH OF:

JUL (30 JUN - 29 JUL)

Figure 10. Statistical summary of tropical cyclone tracks that passed within 180 n mi of Sasebo for the month of July. (Based on data from Chin, 1972, and FWC/JTWC Annual Typhoon Reports 1971-1973).



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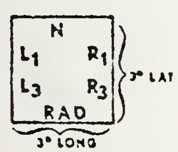

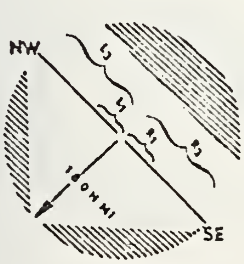

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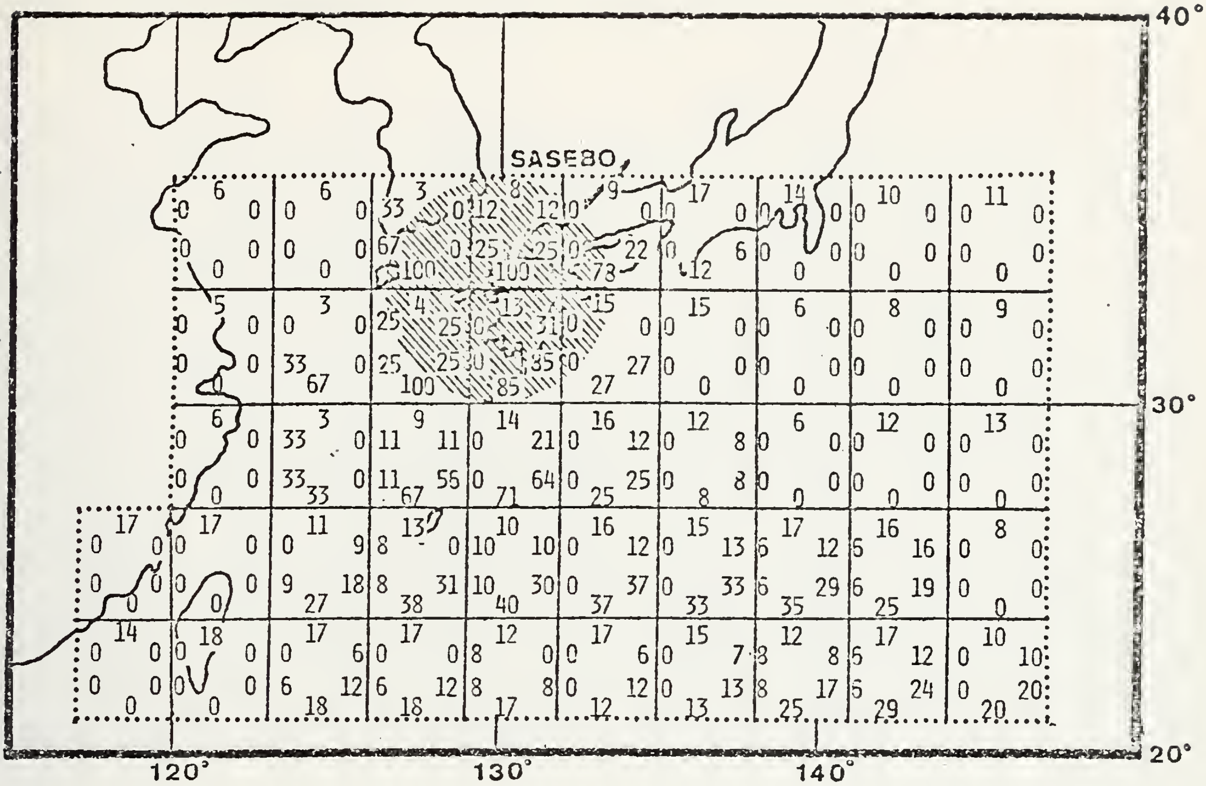
RAD = PERCENT OF TROPICAL CYCLONES THAT PASSED THROUGH THE SQUARE AND SUBSEQUENTLY PASSED WITHIN 180 N MI OF SASEBO

FOR THE MONTH OF:

AUG (30 JUL - 28 AUG)

Figure 11. Statistical summary of tropical cyclone tracks that passed within 180 n mi of Sasebo for the month of August. (Based on data from Chin, 1972, and FWC/JTWC Annual Typhoon Reports 1971-1973)



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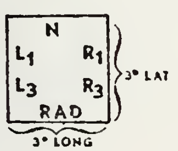


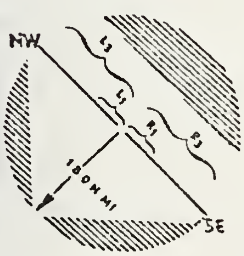
N = NUMBER OF TROPICAL CYCLONES THAT PASSED THROUGH THIS SQUARE FOR THE MONTH

L_1 = PERCENT OF ALL TROPICAL CYCLONES THAT PASSED THROUGH THIS SQUARE AND SUBSEQUENTLY CROSSED A LINE EXTENDING NW FROM SASEBO WITHIN A DISTANCE OF 60 N MI (1° LAT)

L_3 = PERCENT OF ALL TROPICAL CYCLONES THAT PASSED THROUGH THIS SQUARE AND SUBSEQUENTLY CROSSED A LINE EXTENDING NW FROM SASEBO WITHIN A DISTANCE OF 180 N MI (3° LAT)

R_1 = PERCENT OF ALL TROPICAL CYCLONES THAT PASSED THROUGH THIS SQUARE AND SUBSEQUENTLY CROSSED A LINE EXTENDING SE FROM SASEBO WITHIN A DISTANCE OF 60 N MI (1° LAT)

R_3 = PERCENT OF ALL TROPICAL CYCLONES THAT PASSED THROUGH THIS SQUARE AND SUBSEQUENTLY CROSSED A LINE EXTENDING SE FROM SASEBO WITHIN A DISTANCE OF 180 N MI (3° LAT)

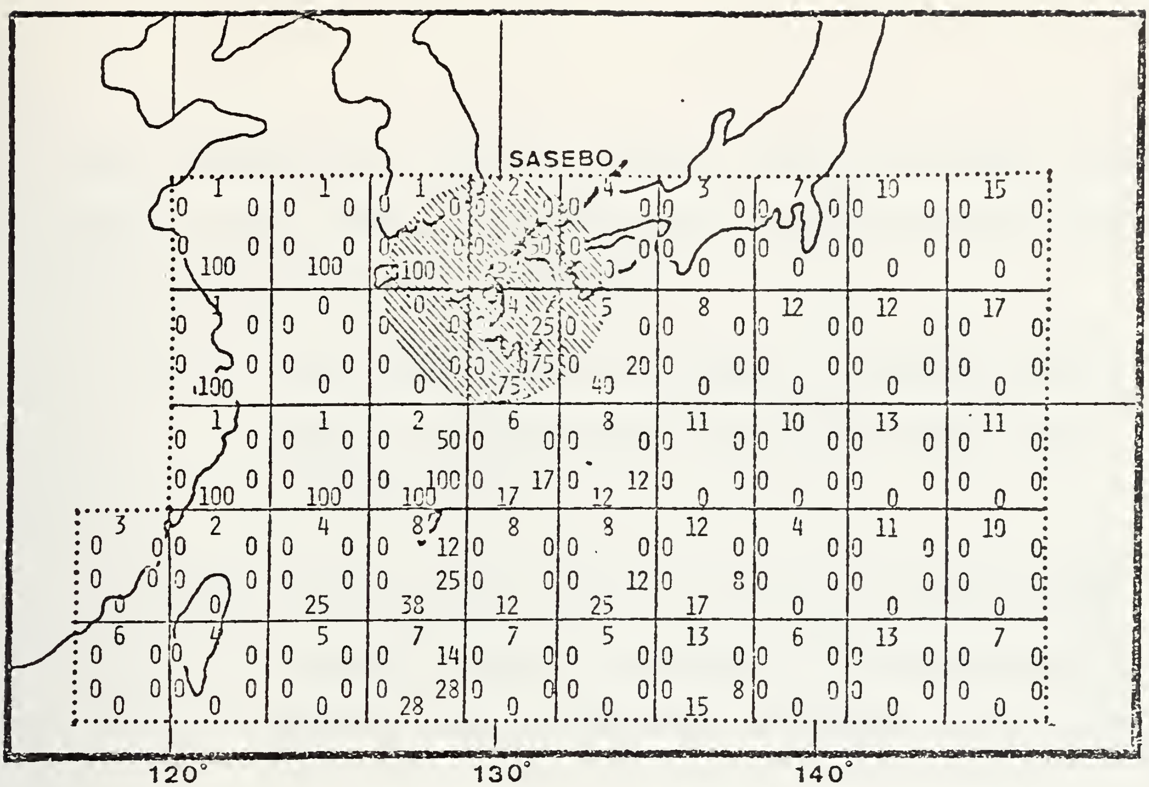


RAD = PERCENT OF TROPICAL CYCLONES THAT PASSED THROUGH THE SQUARE AND SUBSEQUENTLY PASSED WITHIN 180 N MI OF SASEBO

FOR THE MONTH OF:

SEP (29 AUG - 27 SEP)

Figure 12. Statistical summary of tropical cyclone tracks that passed within 180 n mi of Sasebo for the month of September. (Based on data from Chin, 1972, and FWC/JTWC Annual Typhoon Reports 1971-1973)



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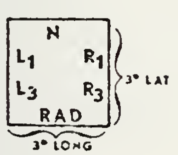

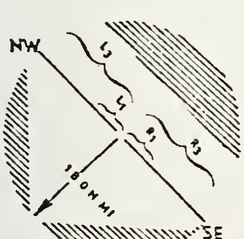

N = NUMBER OF TROPICAL CYCLONES THAT PASSED THROUGH THIS SQUARE FOR THE MONTH

L_1 = PERCENT OF ALL TROPICAL CYCLONES THAT PASSED THROUGH THIS SQUARE AND SUBSEQUENTLY CROSSED A LINE EXTENDING NW FROM SASEBO WITHIN A DISTANCE OF 60 N MI (1° LAT)

L_3 = PERCENT OF ALL TROPICAL CYCLONES THAT PASSED THROUGH THIS SQUARE AND SUBSEQUENTLY CROSSED A LINE EXTENDING NW FROM SASEBO WITHIN A DISTANCE OF 180 N MI (3° LAT)

R_1 = PERCENT OF ALL TROPICAL CYCLONES THAT PASSED THROUGH THIS SQUARE AND SUBSEQUENTLY CROSSED A LINE EXTENDING SE FROM SASEBO WITHIN A DISTANCE OF 60 N MI (1° LAT)

R_3 = PERCENT OF ALL TROPICAL CYCLONES THAT PASSED THROUGH THIS SQUARE AND SUBSEQUENTLY CROSSED A LINE EXTENDING SE FROM SASEBO WITHIN A DISTANCE OF 180 N MI (3° LAT)

RAD = PERCENT OF TROPICAL CYCLONES THAT PASSED THROUGH THE SQUARE AND SUBSEQUENTLY PASSED WITHIN 180 N MI OF SASEBO

FOR THE MONTH OF:

OCT (28 SEP - 27 OCT)

Figure 13. Statistical summary of tropical cyclone tracks that passed within 180 n mi of Sasebo for the month of October. (Based on data from Chin, 1972, and FWC/JTWC Annual Typhoon Reports 1971-1973)

were recorded for five-day periods, exact calendar months could not be used. To assess the threat to Sasebo, the following parameters were used:

N: The total number of tropical cyclones that passed through each 3 lat/long square for a given month

RAD: The percent of those tropical cyclones that passed through the square and subsequently passed within 180 n mi of Sasebo

R_1: Percentage of all tropical cyclones that passed through the square and <u>subsequently</u> crossed a line extending <u>60 n mi southeast</u> of Sasebo (1 latitude)

R_3: Percentage of all tropical cyclones that passed through the square and <u>subsequently</u> crossed a line extending <u>180 n mi southeast</u> of Sasebo (3 latitude)

L_1: Percentage of all tropical cyclones that passed through the square and <u>subsequently</u> crossed a line extending <u>60 n mi northwest</u> of Sasebo (1 latitude)

L_3: Percentage of all tropical cyclones that passed through the square and <u>subsequently</u> crossed a line extending <u>180 n mi northwest</u> of Sasebo (3 latitude).

N and RAD are printed on the top and bottom of the square respectively. L_1 and L_3 are printed at the left, and R_1 and R_3 at the right edges of the square.

For example, in Figure 9, the 3 degree square located between 123E to 126E and 27N to 30N had 9 tropical cyclones pass through it during the years 1947-1973. Of these, 67 percent approached within 180 n mi of Sasebo; 11 percent passed within 60 n mi southeast and 22 percent within 180 n mi to the southeast. Twenty-two percent of the storms passed within 60 n mi to the northwest and 33 percent passed within 180 n mi to the northwest.

Figures 14 to 18 represent an analysis of the RAD number from the above figures. The solid lines represent the "percent threat" for any storm location. The dashed lines represent approximate approach times to Sasebo, computed from the average tropical cyclone speed of movement for June-October from NAVAIR 50-1C-62. The average speeds are presented in Table 2. For example, in Figure 14, a storm located at 123E and 27N has a 60 percent probability of passing within 180 n mi of Sasebo, and it could reach Sasebo in one day.

Note the significant shift in direction from which "threat" tropical cyclones approach Sasebo (Figures 14 - 18). In June, the "threat" is from the S; whereas in July, it is from the SE. During August, the "threat" sector extends from S-SE and then narrows to SE again in September and October.

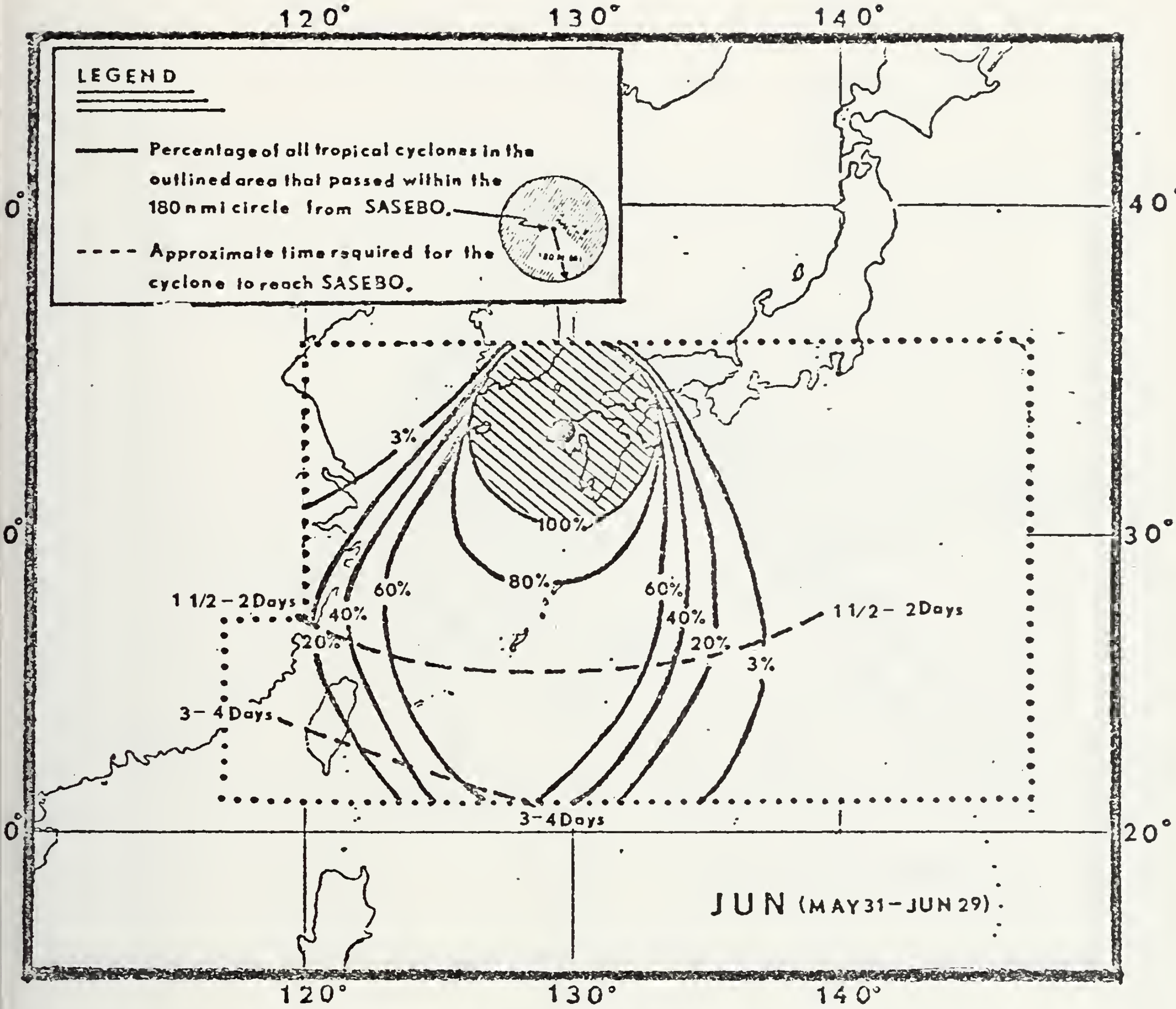

Figure 14. Percentage of tropical cyclones that passed within 180 n mi of Sasebo for the month of June. (Based on data from 1947-1973)

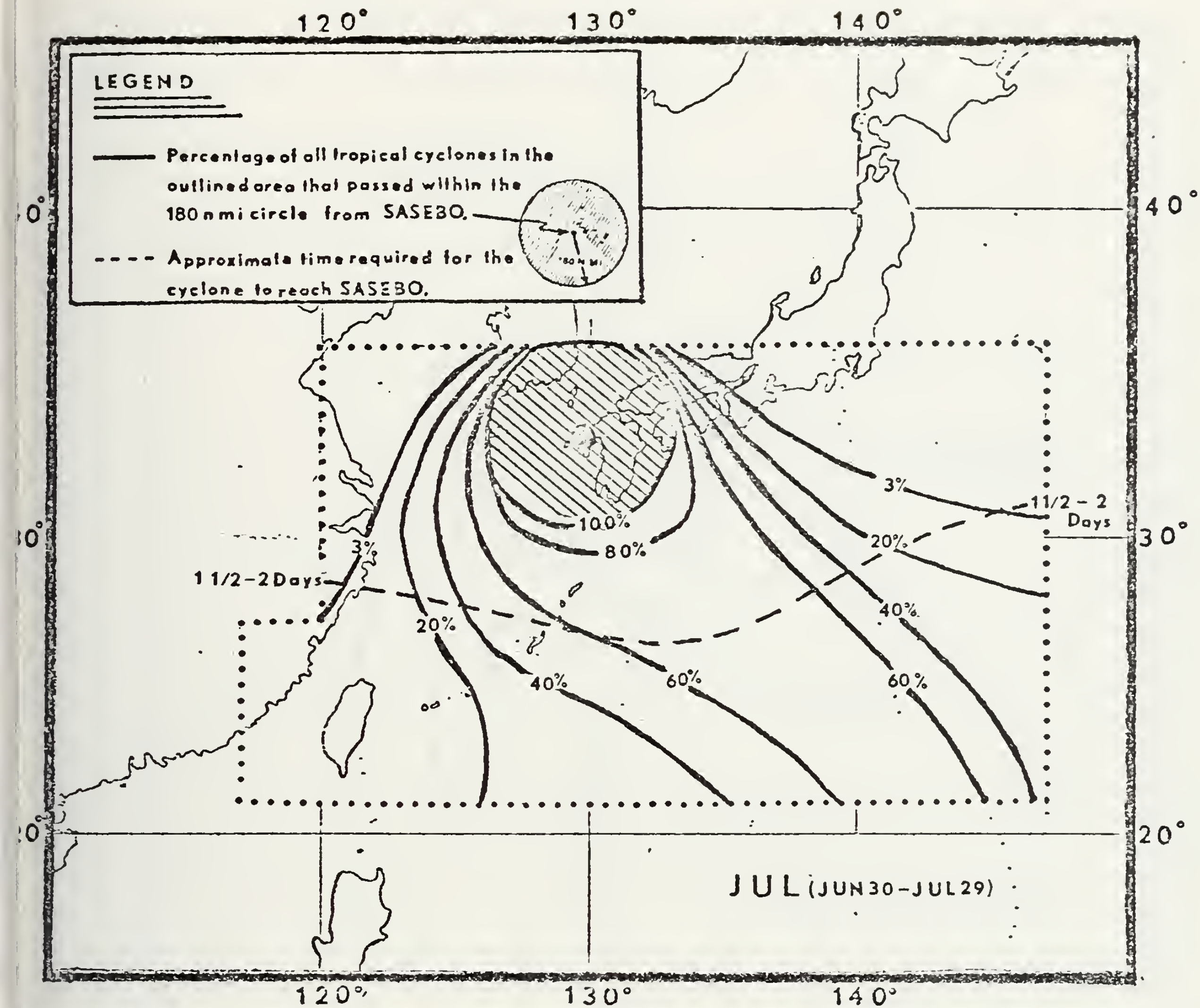

Figure 15. Percentage of tropical cyclones that passed within 180 n mi of Sasebo for the month of July. (Based on data from 1947-1973)

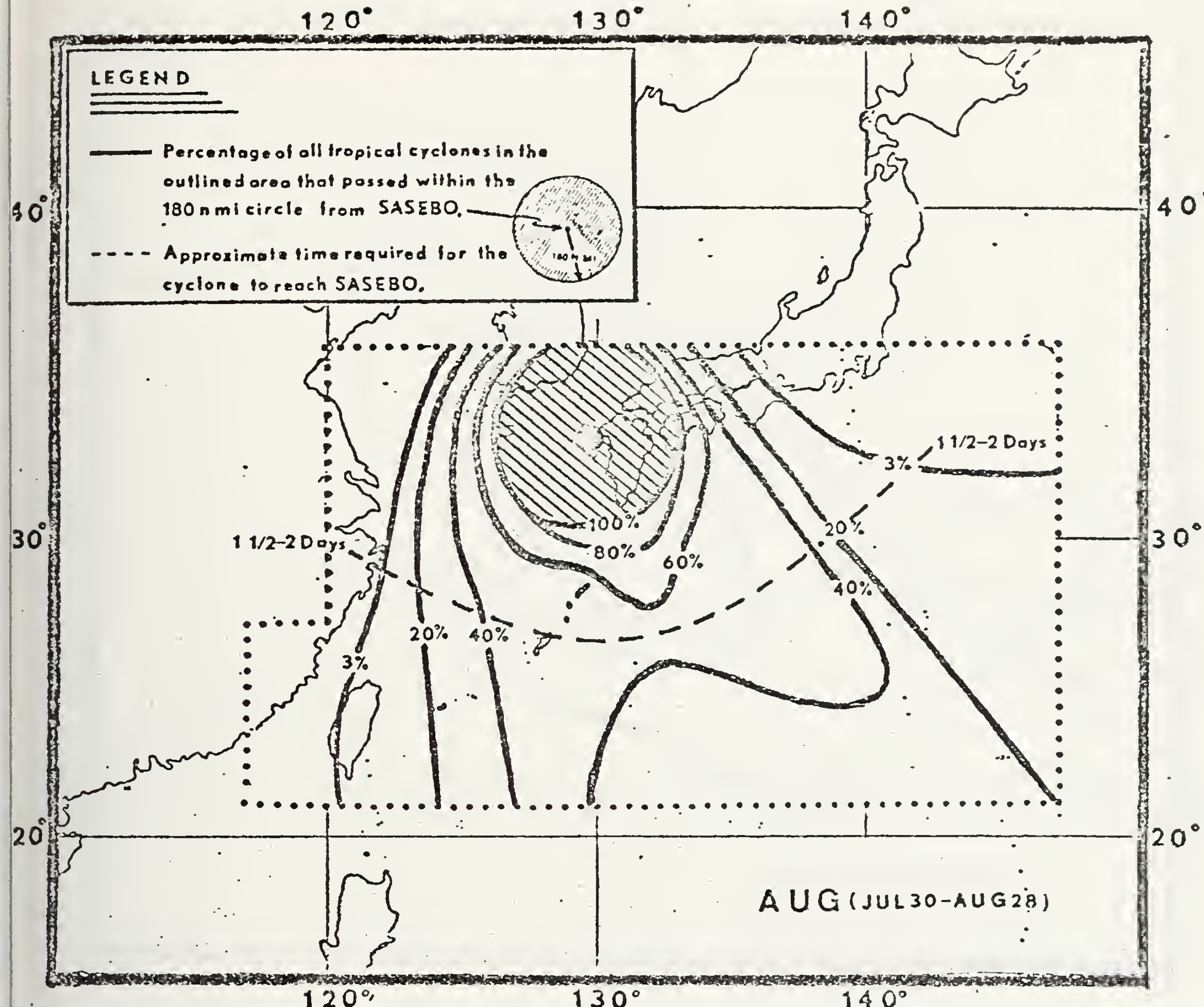

Figure 16. Percentage of tropical cyclones that passed within 180 n mi of Sasebo for the month of August (Based on data from 1947-1973)

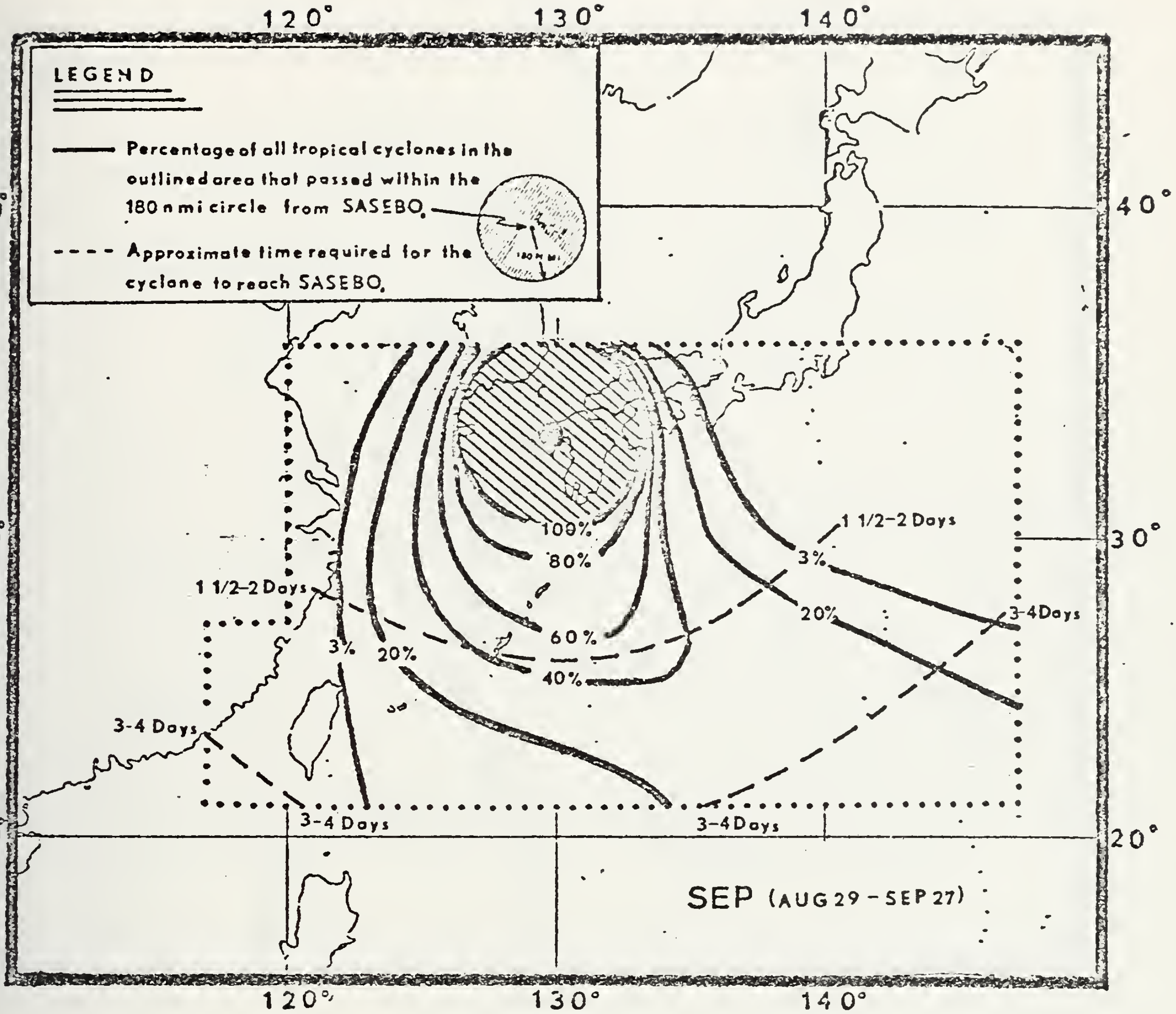

Figure 17. Percentage of tropical cyclones that passed within 180 n mi of Sasebo for the month of September. (Based on data from 1947-1973)

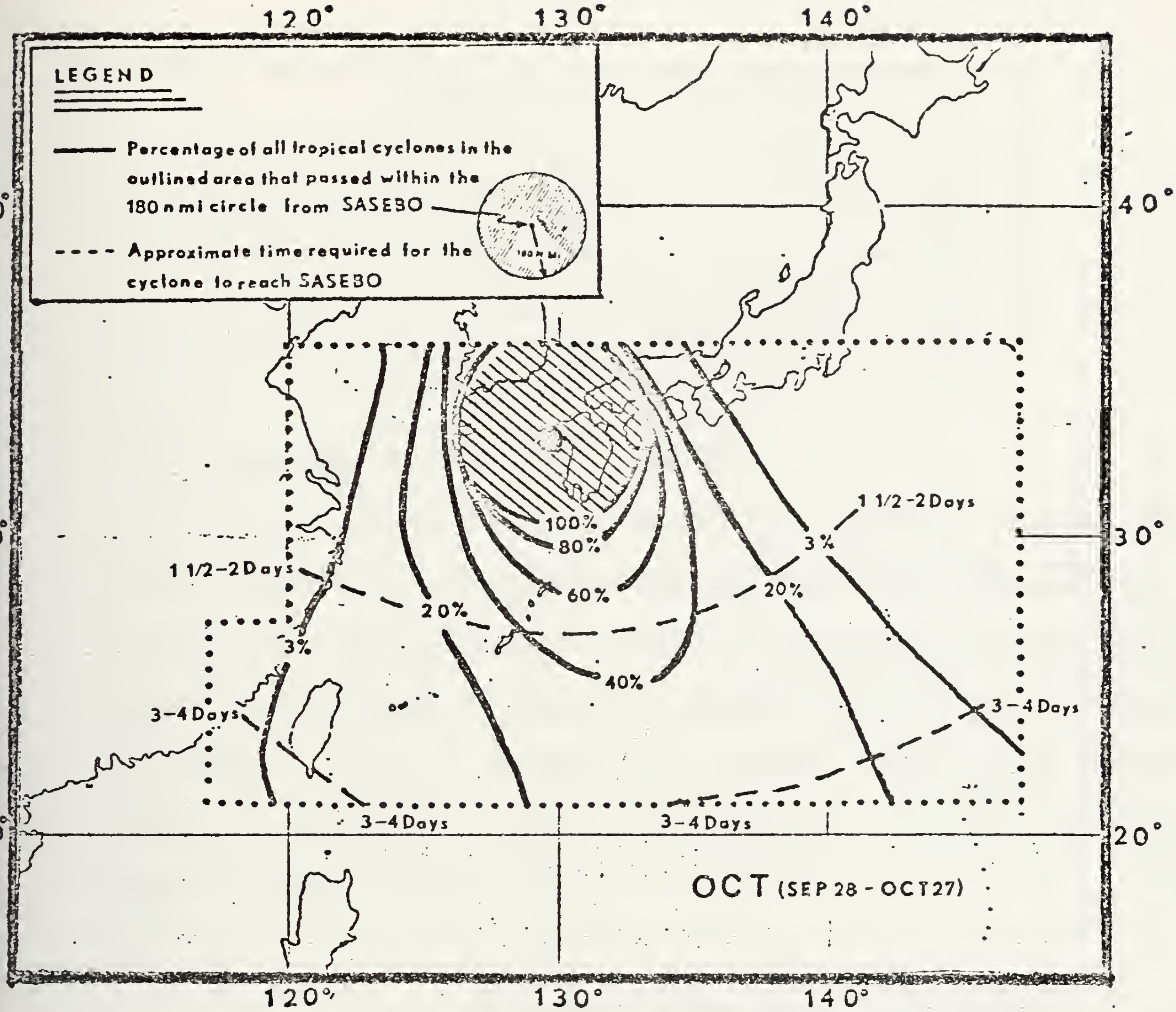

Figure 18. Percentage of tropical cyclones that passed within 180 n mi of Sasebo for the month of October. (Based on data from 1947-1973)

Table 2. Average tropical cyclone speed of movement in knots per 5 degrees northern latitude for June-October.

	JUN	JUL	AUG	SEP	OCT	AVG
30-35 N	25	13	13	18	18	17.4
25-30 N	18	12	10	14	15	13.8
20-25 N	11	11	10	12	13	11.4
15-20 N	10	10	10	11	11	10.4

5.2 WIND AND TOPOGRAPHICAL EFFECT

A total of 43 tropical cyclones approached within 180 n mi of Sasebo in the fifteen-year period from 1959-1973 during the months June-October.[4] Table 3a groups the 43 tropical cyclones according to the wind intensity that they produced at Sasebo. Of the 43 tropical cyclones, 63 percent resulted in strong winds (≥ 22 kt) and 35 percent resulted in gale force winds (≥ 34 kt).

Table 3a. Extent to which tropical cyclones affected Sasebo during the period June-October, 1959-1973.

Number of tropical cyclones that passed within 180 n mi of Sasebo	43	%
Number of tropical cyclones resulting in strong (≥ 22 kt) winds in Sasebo	27	63%
Number of tropical cyclones resulting in gale force (≥ 34 kt) winds in Sasebo	15	35%

[4]From Chin (1972) for years 1959-1970 and from Annual Typhoon Reports for years 1971-1973 (FWC/JTWC, 1971-1973).

JUNE

(31 May - 29 June)

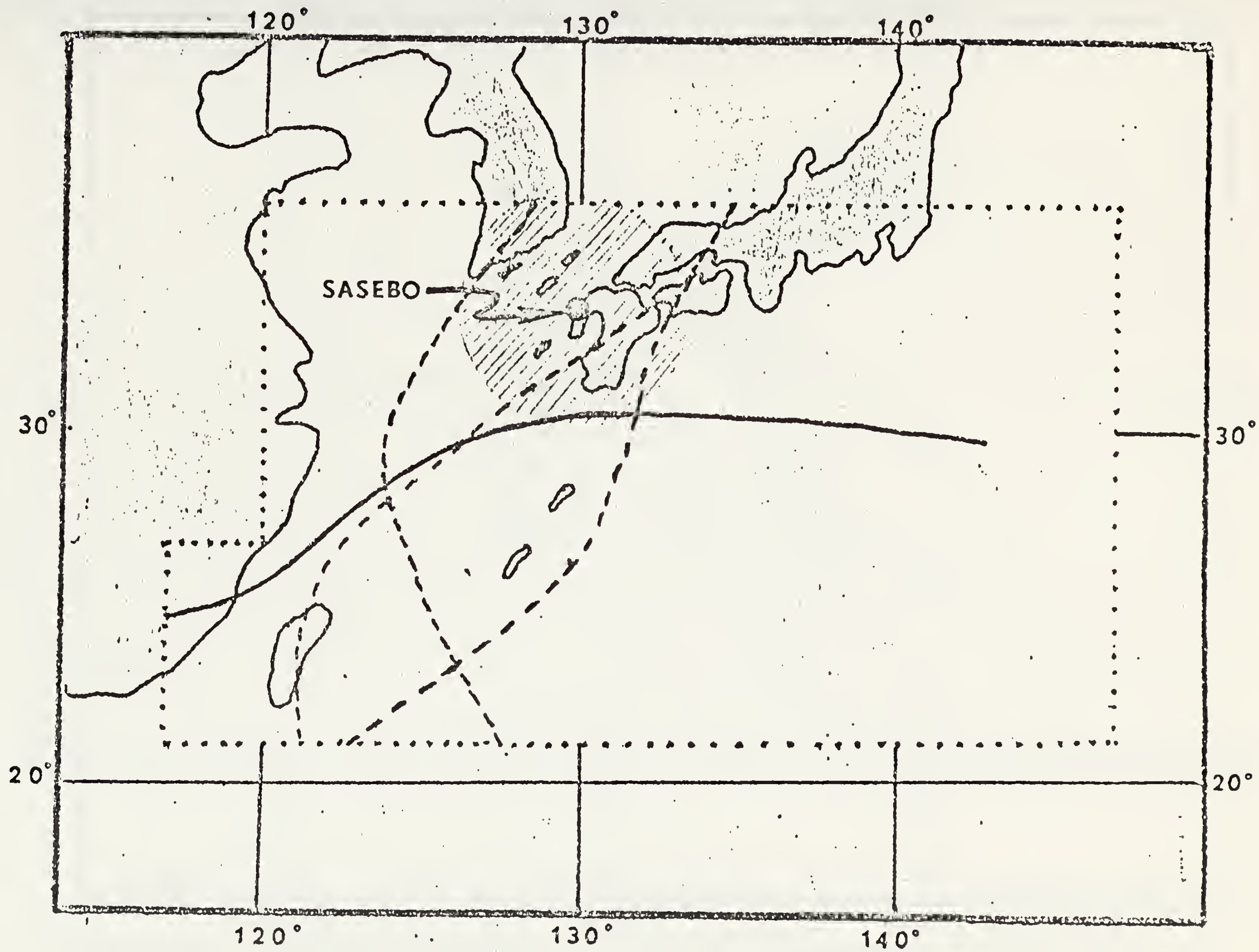

Figure 19. Tracks of tropical cyclones approaching within 180 n mi of Sasebo during the 15-year period, 1959-73 for June. Solid line indicates tracks of tropical cyclones that produced winds $\geq$ 34 kt at Sasebo. Dashed line indicates tropical cyclones passing within 180 n mi of Sasebo but not producing winds $\geq$ 34 kt at Sasebo.

JULY

30 June - 29 July

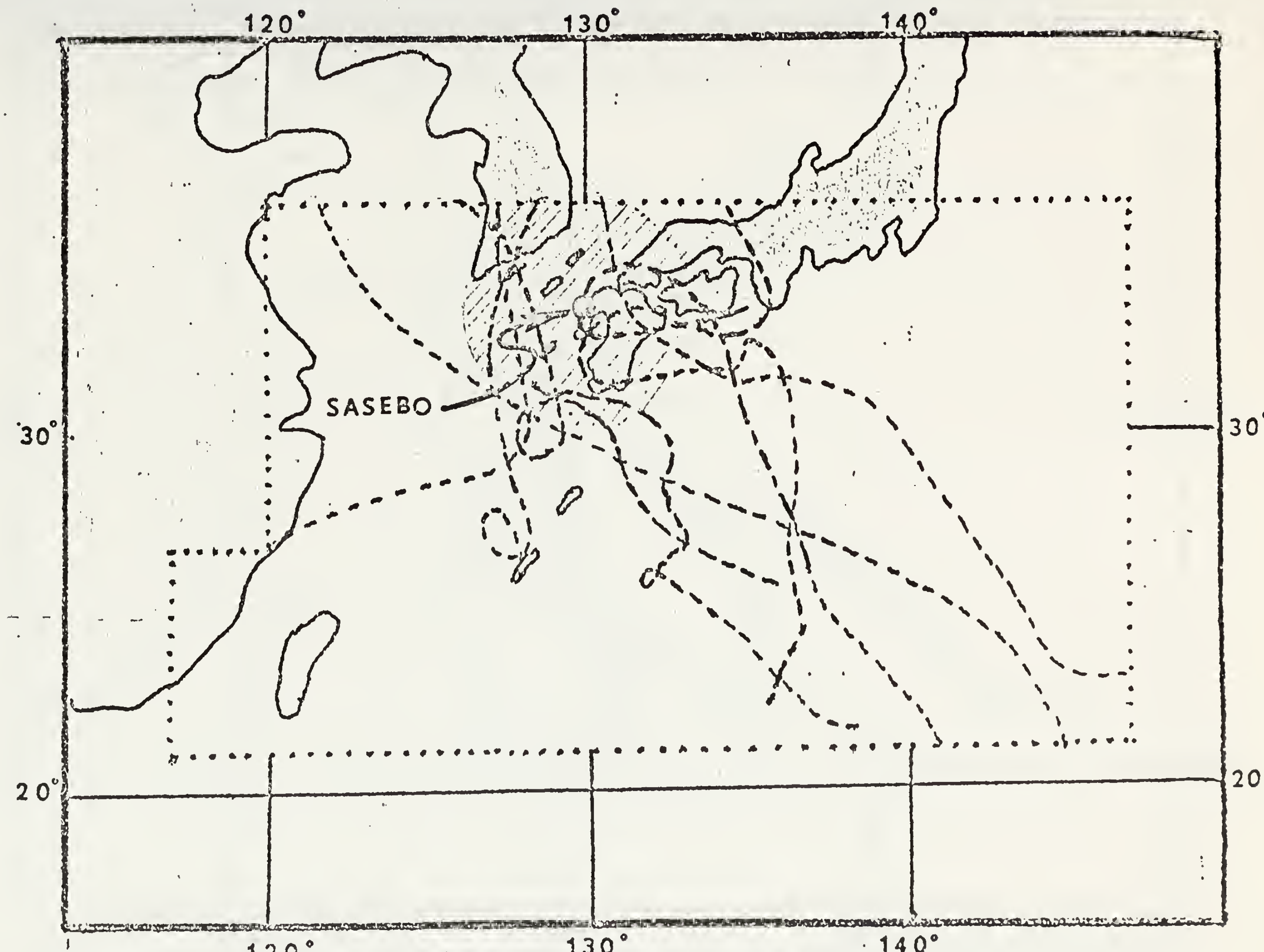

Figure 20. Tracks of tropical cyclones approaching within 180 n mi of Sasebo during the 15-year period, 1959-73 for July. Solid line indicates tracks of tropical cyclones that produced winds $\geq$ 34 kt at Sasebo. Dashed line indicates tropical cyclones passing within 180 n mi of Sasebo but not producing winds $\geq$ 34 kt at Sasebo.

AUGUST

30 July - 13 August

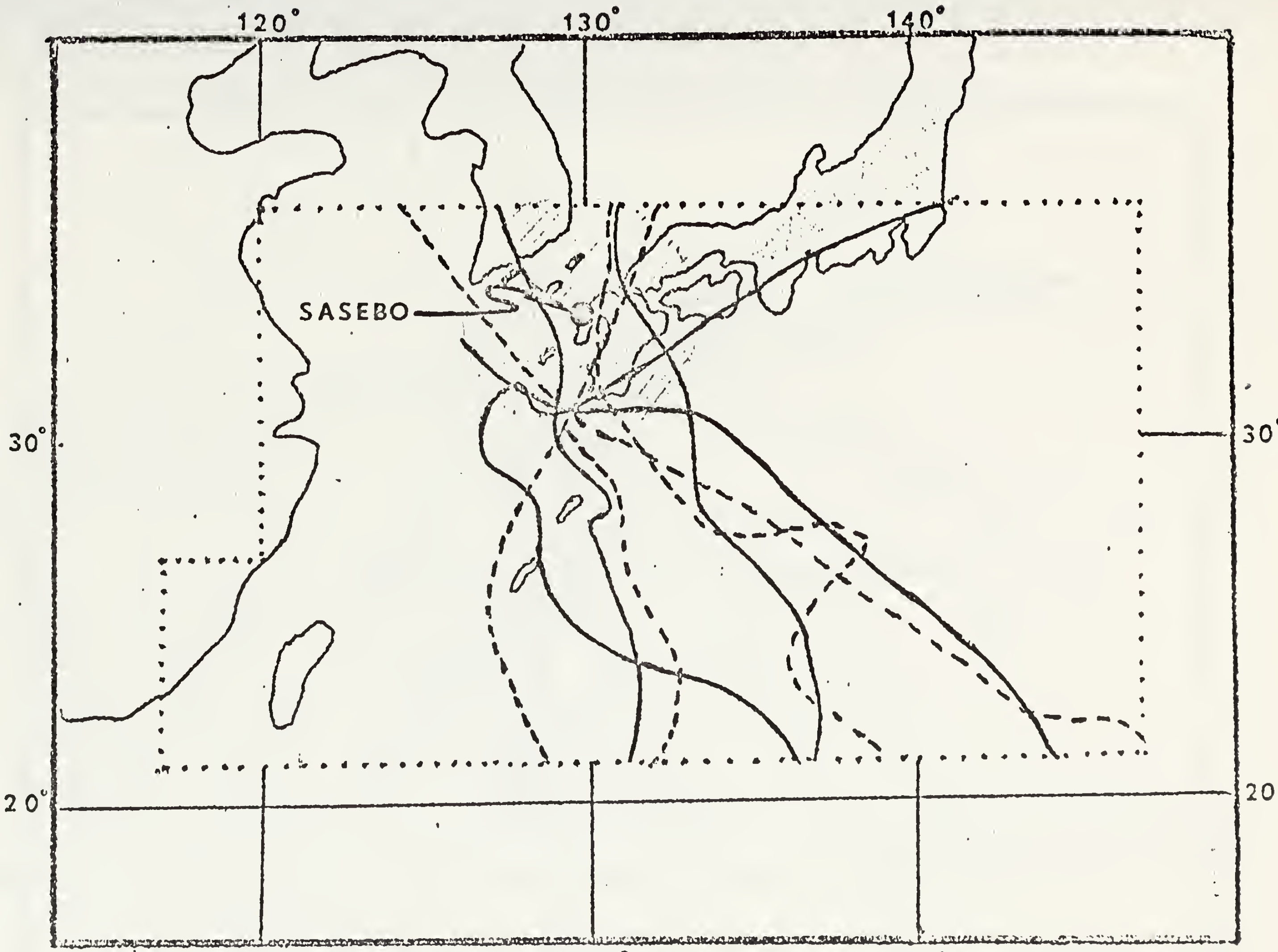

Figure 21. Tracks of tropical cyclones approaching within 180 n mi of Sasebo during the 15-year period, 1959-73 for August. Solid line indicates tracks of tropical cyclones that produced winds ≥ 34 kt at Sasebo. Dashed line indicates tropical cyclones passing within 180 n mi of Sasebo but not producing winds ≥ 34 kt at Sasebo.

AUGUST

14August-28August

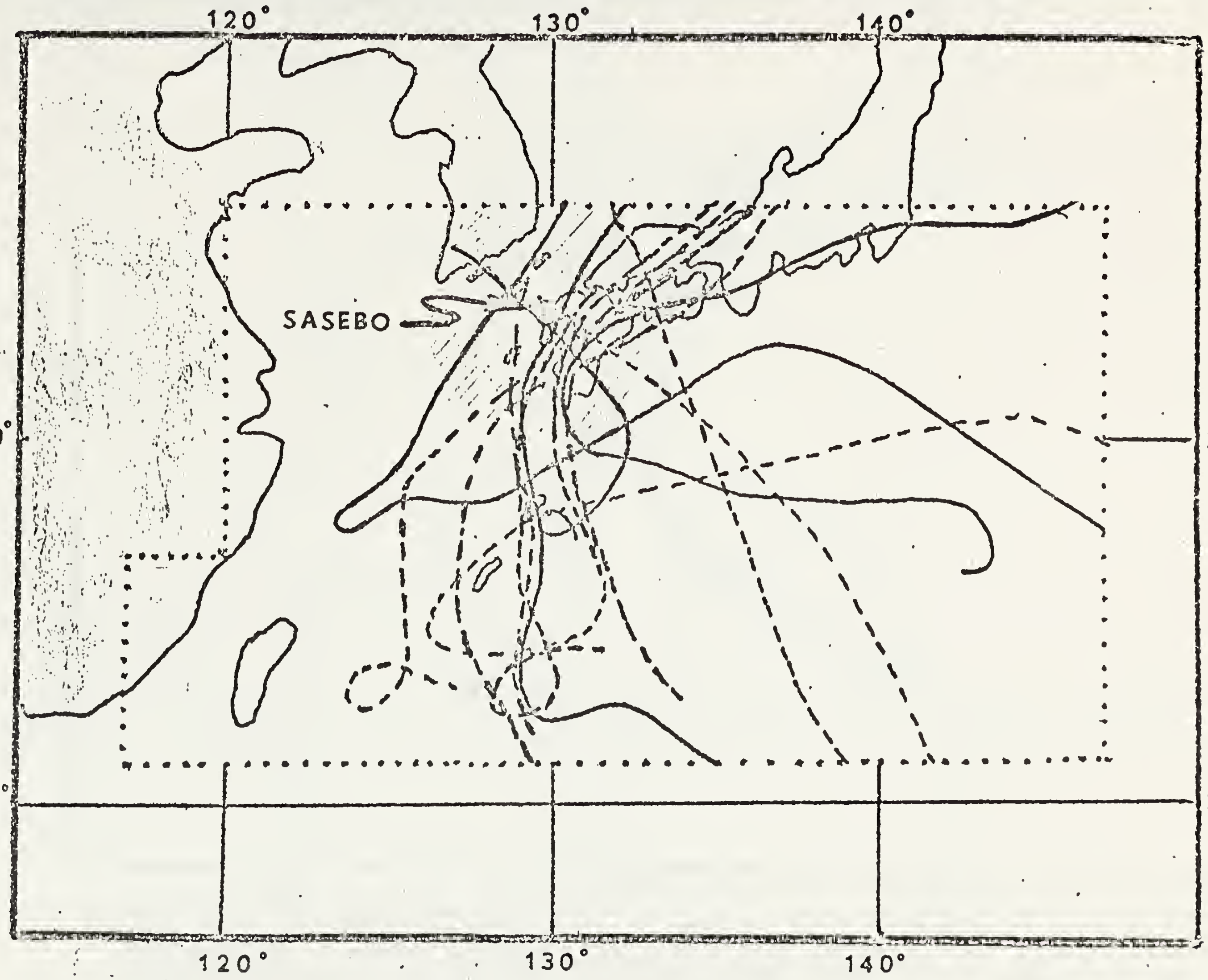

Figure 22. Tracks of tropical cyclones approaching 180 n mi of Sasebo during the 15-year period, 1959-73 for 14-28 August. Solid line indicates tracks of tropical cyclones that produced winds ≥ 34 kt at Sasebo. Dashed line indicates tropical cyclones passing within 180 n mi of Sasebo but not producing winds ≥ 34 kt at Sasebo.

SEPTEMBER

29 August – 27 September

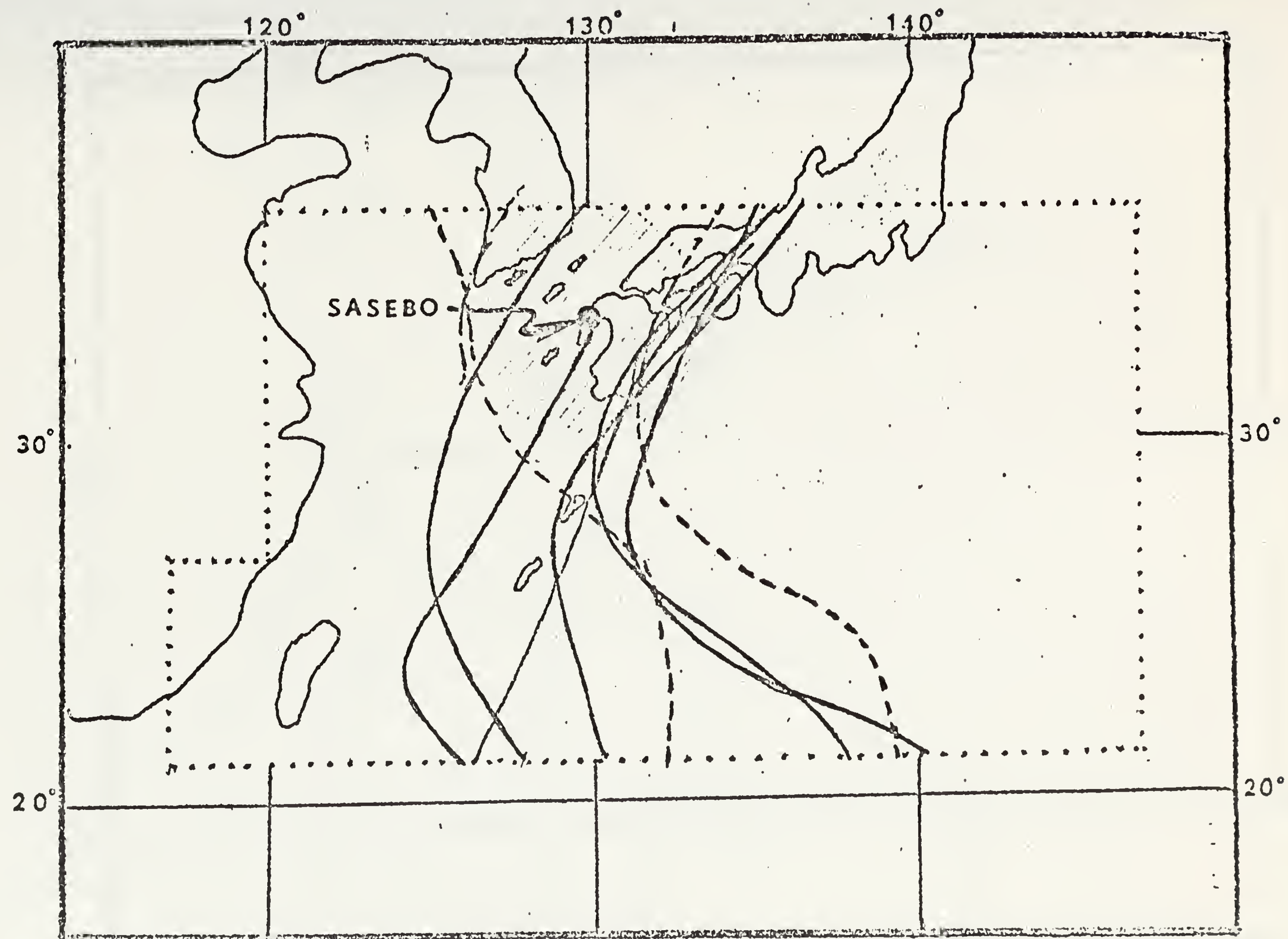

Figure 23. Tracks of tropical cyclones approaching 180 n mi of Sasebo during the 15-year period, 1959-73 for September. Solid line indicates tracks of tropical cyclones that produced winds $\geq$ 34 kt at Sasebo. Dashed line indicates tropical cyclones passing within 180 n mi of Sasebo but not producing winds $\geq$ 34 kt at Sasebo.

OCTOBER

28September-27October

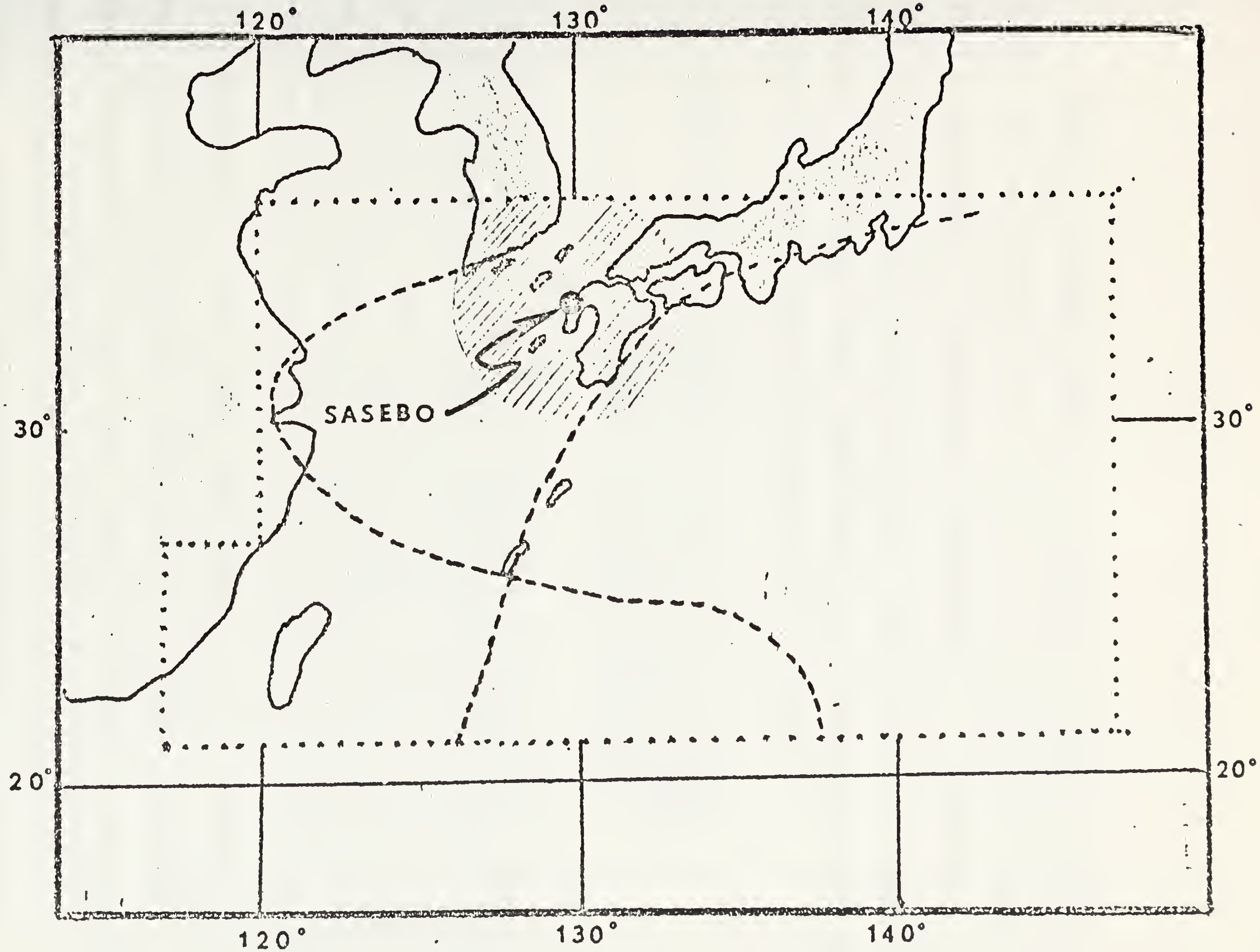

Figure 24. Tracks of tropical cyclones approaching 180 n mi of Sasebo during the 15-year period, 1959-73 for October. Solid line indicates tracks of tropical cyclones that produced winds $\geq$ 34 kt at Sasebo. Dashed line indicates tropical cyclones passing within 180 n mi of Sasebo but not producing winds $\geq$ 34 kt at Sasebo.

Table 3b breaks down the "threat" tropical cyclones by month and resulting wind intensity recorded at Sasebo. It is interesting to note that in September, out of seven tropical cyclones, six produced winds of gale force strength; whereas, in August only eight out of 15 tropical cyclones produced winds of the same intensity in Sasebo.

Table 3b. Extent to which the 43 tropical cyclones from Table 3a affected Sasebo during the period June - October 1959-1973, by month.

Wind intensity produced at Sasebo	Jun	Jul	Aug	Sep	Oct	Total
Winds < 22 kt	2	6	5	2	1	16
Winds ≥ 22 kt	2	2	15	7	1	27
Winds ≥ 34 kt	1	0	8	6	0	15

Figures 19 - 24 depict the tracks of the "threat" tropical cyclones during the fifteen-year period, 1959-1973. Those resulting in gale force winds at Sasebo during the months of June-October are indicated by a solid line. "Threat" tropical cyclone tracks resulting in winds less than 34 kt are depicted by a dashed line. From analysis of the "threat" tropical cyclone tracks, (Figures 19 - 24) it is apparent that those tropical cyclones that result in gales at Sasebo, generally, fall into two categories: those that passed east of Sasebo, and those that passed west of Sasebo. This difference is the key factor in determining to what

extent an individual tropical cyclone will affect Sasebo. If the tropical cyclone path is to the east, across Kyushu, the tropical cyclone will lose some of its intensity through interaction with the land. In addition, the Kyushu Mountains (See Figure 4) will provide protection from the winds of the tropical cyclone. An example of this was Typhoon Bess (Aug. 1963) which crossed Kyushu with a CPA of 80 n mi northeast of Sasebo.[5]

In the case of a tropical cyclone passing west of Sasebo, the path is primarily over water. From Figures 4 - 6, it is evident that the protection offered by topography to the south and west is much less than to the north and east of Sasebo. In addition, tropical cyclone passage to the west places Sasebo in the "dangerous" or right semicircle subjecting the harbor to higher wind velocities. An example of this case was Typhoon Gilda (July 1974)[5]. The CPA of Typhoon Gilda was to the west at approximately the same distance (80 n mi) as Typhoon Bess and both typhoons had center winds of about the same intensity. However, Typhoon Gilda produced winds of 45 kt at Sasebo; whereas, Typhoon Bess resulted in winds of 38 kt at Sasebo.

It must be pointed out that all of the wind data evaluations are based on the assumption that the "threat" tropical

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[5]See Appendix E for case studies on Typhoon Bess (Aug. 1963) and Typhoon Olive (Aug. 1971) passing east of Sasebo and Typhoon Gilda (July 1974) passing west of Sasebo.

cyclone was solely responsible for the winds produced at Sasebo. This assumption does not take into account other extratropical synoptic features existing at the time which could "bias" the winds observed in Sasebo.

Since all of the hourly wind data analyzed during the fifteen-year period, 1959-1973, was provided by the Japanese Weather Bureau, another "bias" in the wind data must be pointed out. Figure 6 indicates the presence of a hill south of the Japanese Weather Bureau. Since the anemometer of the station does not extend above this hill, southerly winds recorded at the Japanese Weather Bureau will be less than actual winds experienced by ships in the harbor. This fact is readily apparent when comparing the Japanese Weather Bureau observations during Typhoon Gilda's passage west of Sasebo to other observations (See Appendix E, Table E1).

Figure 25 shows the position of tropical cyclone centers when strong winds ($\geq$ 22 kt) were first and last recorded at Sasebo. It is apparent that "threat" tropical cyclones, as far away at 360 n mi, may generally produce winds $\geq$ 22 kt in Sasebo. Figure 26 shows tropical cyclone center positions when gale force ($\geq$ 34 kt) winds were first and last recorded at Sasebo. It can be seen that winds $\geq$ 34 kt generally do not begin until the storm is about 180 n mi away. In analyzing Figures 25 and 26, one must keep in mind the following: 1) a greater number of "threat" tropical cyclones will pass to the east of Sasebo, and 2) the fact that a "bias" is associated with the wind observations used in this analysis.

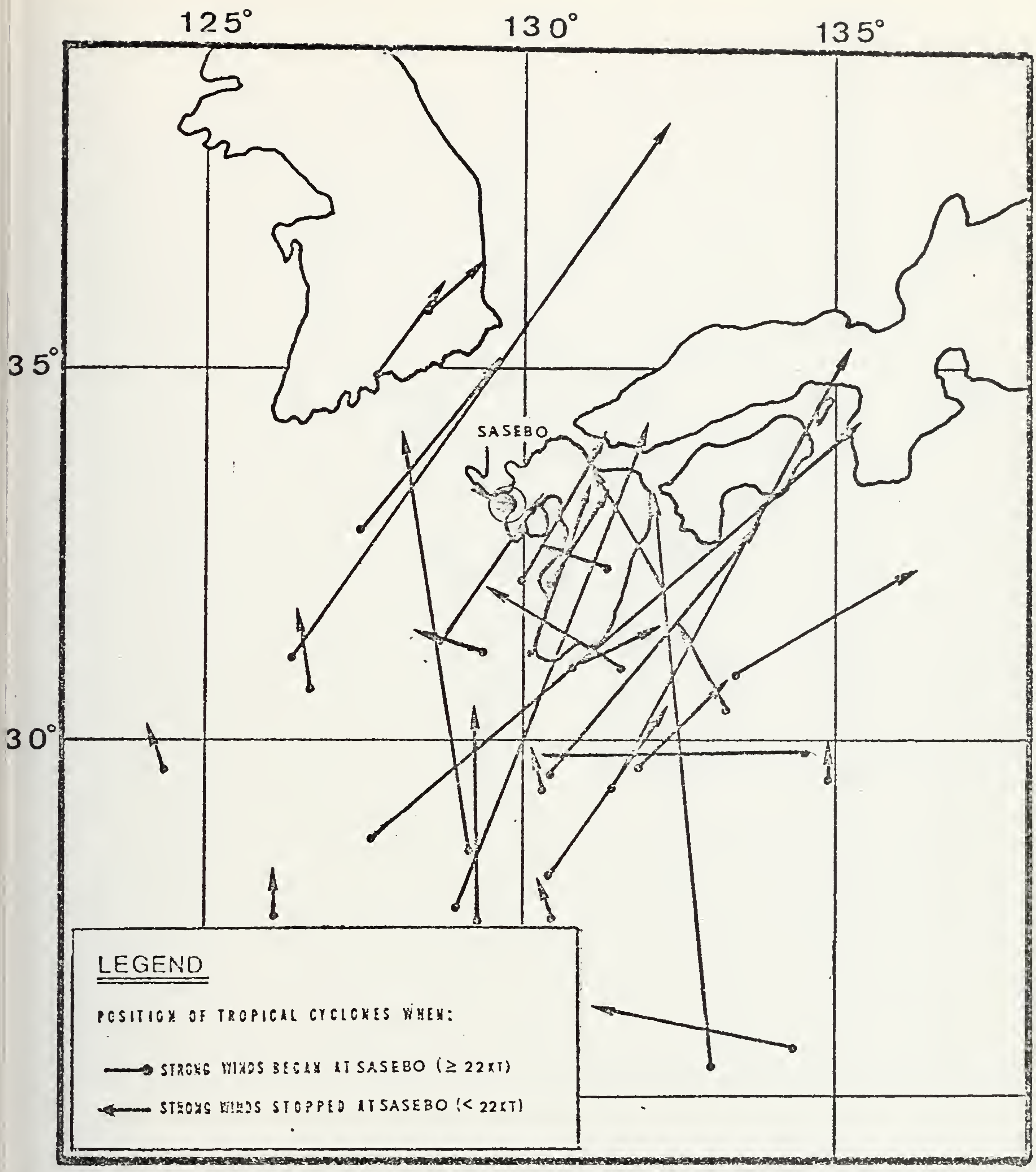

Figure 25. Positions of tropical cyclone centers when ≥ 22 kt winds first and last occurred at Sasebo. (Based on data from the years 1959-1973)

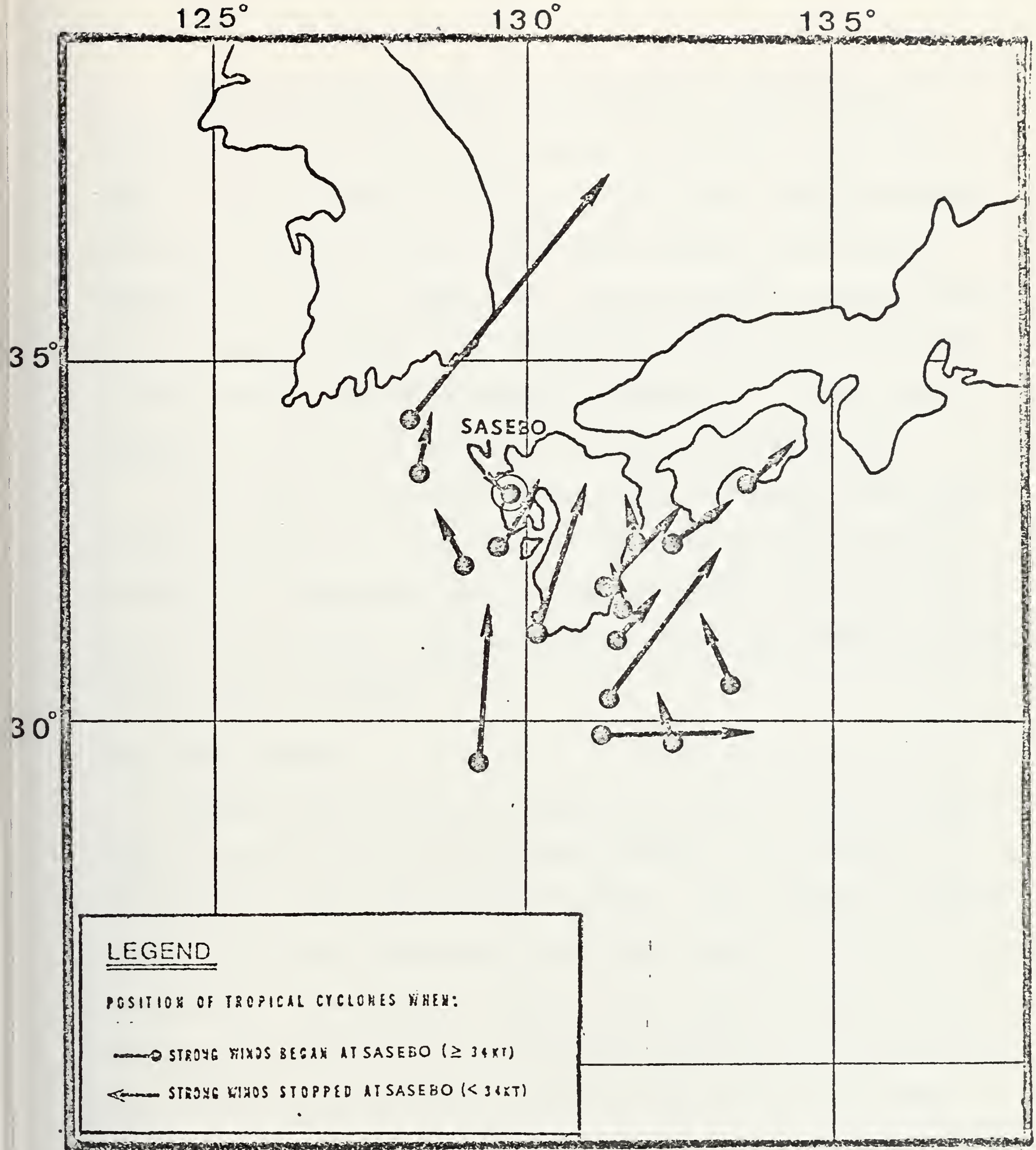

Figure 26. Positions of tropical cyclone centers when ≥ 34 kt winds first and last occurred at Sasebo. (Based on data from the years 1959-1973.)

The most severe threat to the harbor occurs when a tropical cyclone approaches from the southwest and passes west of Sasebo within 50 n mi. In this case, the elevations of Hario Island serve as a good wind barrier for ships at typhoon anchorage at Ebisu Bay. When tropical cyclones pass to the east of Sasebo, the elevations to the north and east of the harbor provide excellent protection. In this case, maximum winds can be expected from NNE (See Figure 6).

In general, the winds experienced in Sasebo Harbor due to the passage of a tropical cyclone will be approximately one-half the intensity of the maximum center winds when passing to the east and somewhat greater than half when passing to the west of Sasebo.[6]

5.3 WAVE ACTION

Maximum wave action is associated with a typhoon passing to the west since this places Sasebo in the right or "dangerous" semicircle of the typhoon. The greater relative wind in this area generates waves which tend to be more destructive. Because the shape of the harbor reduces the fetch, and because of the relatively narrow harbor entrance, the effects of the typhoon related winds and sea are minimized. The maximum wave heights that can be expected with typhoon strength winds ($\geq$ 64 kt) are 7 ft near India Basin and 9 ft at typhoon anchorage.[7]

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[6] U.S. Navy Fleet Weather Facility, Yokosuka, Japan, 1967: Typhoon Havens: Japan-Korea-Okinawa.

[7] Based on Forecasting Curves for Shallow-Water Waves from U.S. Army Coastal Engineering Research Center, 1973: Shore Protection Manual (Volume I).

5.4 STORM SURGE AND TIDES

When a tropical cyclone crosses a coastline, a rise in water level may occur. This is caused by wind stress on the water surface and the effects of atmospheric pressure reduction. Also tides may act to either increase or decrease this rise in water level.

The storm surge effect is most evident in the shallow waters of large inland bays open to the south coast of Japan.[8] The height of the storm surge in a given port is dependent on the tropical cyclone track. If the track is to the west of the port, the peak surge will be large; while the opposite is true for a track to the east of the port.

Over a five-year period, during which 10 tropical cyclones passed to the west of Sasebo, the maximum tidal height over the normal tide was 1.3 feet. Since the tidal range for Sasebo Harbor is 10 to 12 feet, this relatively small storm surge would be significant only if it coincided with a high Spring tide and large waves. These three factors did coincide in July 1974 with the passage of Typhoon Gilda. Large amounts of water were forced over the southern walls in both Juliet and India Basins. However, even under these extreme conditions, India Basin was considered a safe adequate haven

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[8] Miyazaki, M., 1974: Characteristics of Storm Surges Induced by Typhoons along the Japanese Coast.

by the Commanding Officer of the U. S. Navy vessel berthed at India Nos. 7 and 8 during Typhoon Gilda's passage.[9]

[9]See Appendix E for a detailed case Study on Typhoon Gilda.

6. PREPARATION FOR HEAVY WEATHER

6.1 TROPICAL CYCLONE WARNINGS

It is essential to recognize that the approach of a typhoon is usually signaled by the following indicators:[10]

1. Heavy swell (in front and to the right of the storm).

2. Greater than normal amounts of high cirrus clouds known as "mackerel sky".

3. Irregular or pumping action of barometer followed by a steady drop. The diurnal pressure variation effect (high at 1000 and 2200 local time, low at 0400 and 1600 local time) must be kept in mind. When the diurnal variation is no longer evident, the storm is close.

Tropical cyclone warnings including 24-, 48-, and 72-hr forecasts are issued by the Fleet Weather Central/Joint Typhoon Warning Center (FWC/JTWC), Guam. When the initial warning of a tropical depression, storm or typhoon is received, a running plot of the following should be maintained:

1. Ship's position.

2. Actual and forecast tropical cyclone center position.

3. Areas of dangerous winds (30 kts and above).

Appendix 1 to Annex H of CINCPACFLT OPORD 201-(YR) describes how to calculate the "Danger Area" of a tropical cyclone. A copy of this pertinent section is included in Appendix C.

An average twenty-four hour forecast position error of 135 n mi is commonly used. Burroughs and Brand (1972) showed that the average twenty-four hour forecast error for

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[10] From CINCPACFLT OPORD 201, H-1-5.

recurving typhoons is 141 n mi. For forecast positions verifying after the point of recurvature, the error is increased to 165 n mi. Since the majority of "threat" tropical cyclones are recurvers, it may be prudent to use a radius greater than 135 n mi when determining the danger area. The criteria for setting local heavy weather readiness conditions are discussed in SOPA (ADMIN) Sasebo INST 5000.1 series. Annex W of the instruction is reprinted in Appendix C.

6.2 REMAINING IN PORT

Remaining in port is the recommended course of action for all ships except aircraft carriers. There are no records available of a large, modern aircraft carrier remaining in Sasebo Harbor during the passage of a typhoon. Typhoon anchorages may be too restrictive for an aircraft carrier if many ships are present. Also, due to the large "sail area" of a carrier, the effects of winds would be even greater than that experienced by smaller ships (AR, AF, etc.). In addition, suitable berthing is not available in the inner harbor for an aircraft carrier during the passage of a "threatening" tropical cyclone.

Commander Service Group THREE in SOPA (ADMIN) Sasebo Instruction 5000.1 series makes the following statements pertinent to the use of Sasebo as a typhoon haven:
"Because of local topography, Sasebo Harbor provides excellent shelter during the passage of a typhoon to the east"

"and good shelter during the passage of a typhoon directly over or close to the west. Mooring buoy capacities and suitability of anchorages are adequate. Generally speaking, Sasebo Harbor can be considered a typhoon haven for all but the largest of naval ships."[11]

Figures 27 - 32 show the tropical cyclone threat axis for Sasebo from June-October. The dotted area of the arrow represents a 30 percent or greater probability of a tropical cyclone coming within 180 n mi (indicated by the hatched circle) of Sasebo. In addition, an effort has been made to indicate the most frequent direction of passage, east or west of Sasebo, by displacing the center of the arrow in the corresponding direction.

To correctly assess the threat posed by an approaching tropical cyclone, the following timetable depicted in Figures 27 - 31 was constructed:

I. An existing tropical cyclone, or potential development, in area "A" with forecast movement toward Kyushu:

   a. Review the material condition of the ship

   b. Reconsider all maintenance activities scheduled to exceed 48 hours.

II. A tropical cyclone entering area "B" with forecast movement toward Kyushu:

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[11]See Appendix D for a reprint of SOPA (ADMIN) Sasebo INST 5000.1.

a. Reconsider all maintenance activities scheduled to exceed 24 hours.

b. Prepare ship for heavy weather and movement to typhoon anchorage.

III. A tropical cyclone entering area "C" with forecast movement toward Sasebo:

a. Be prepared to move to typhoon anchorage.

b. Review availability of tugs, pusherboats.

c. Ensure sufficient power available to counter high winds and seas by steaming to the anchor.

A review of Appendix E will provide the reader with an understanding of the conditions which other ships have experienced during storm conditions at Sasebo Harbor. Even though utilization of the typhoon anchorages in the southern part of the harbor is preferred, several commanding officers have noted that India Basin, especially Berths 8 and 9, is suitable for larger ships during the passage of a typhoon. Wet drydocks to the west of India Basin provide excellent shelter for small ships (MSC, ATF, etc.).

There have been only a few incidences where ships have incurred damage from a typhoon while in Sasebo and generally this resulted from ships parting their moorings due to shackle failure. The use of "oversized" or "doubled-up" shackles and steaming to the buoy are recommended. Another possible problem during the passage of a typhoon is that the mothballed LST's moored at Tategami could break loose and present a hazard to other ships.

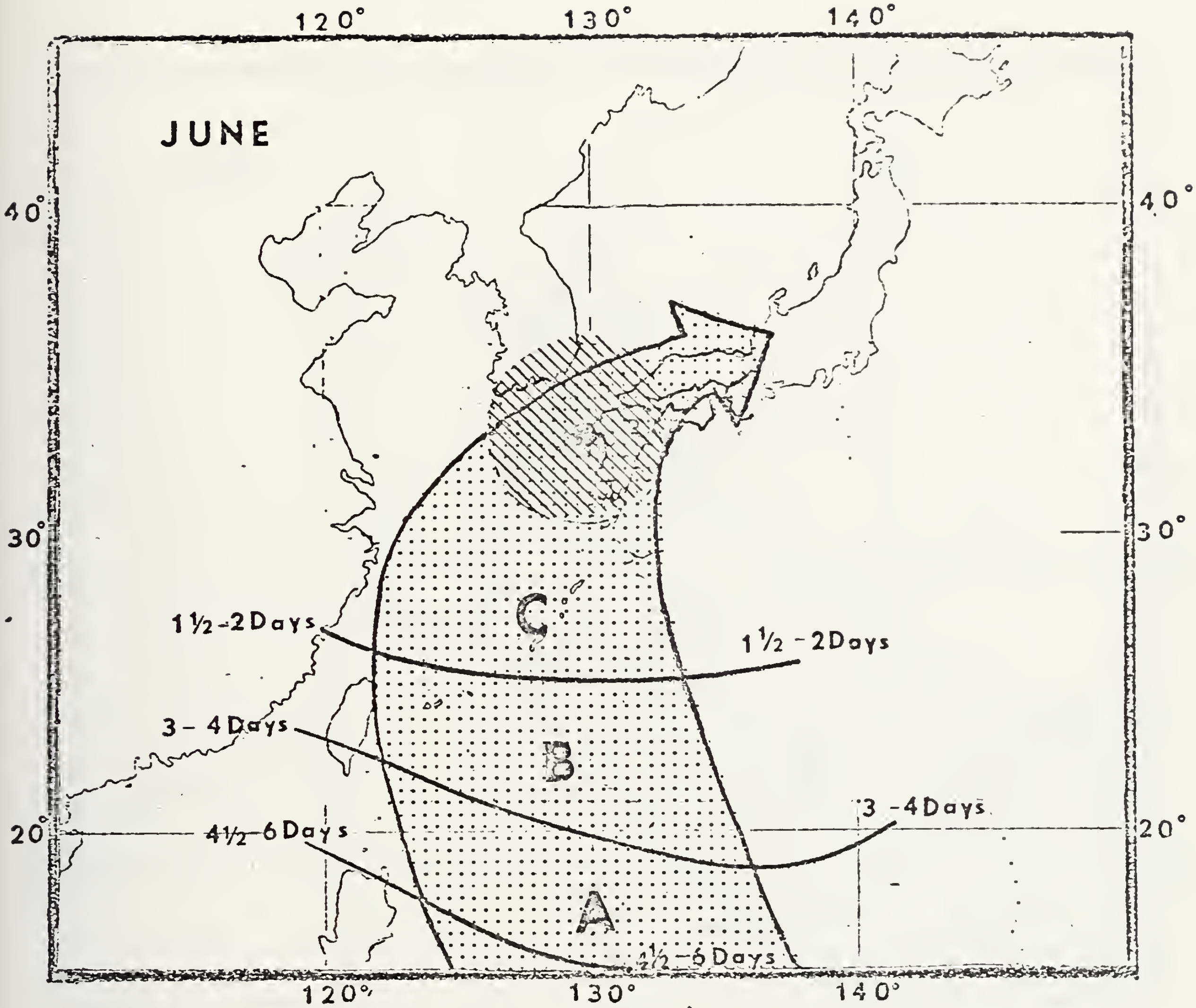

Figure 27. Tropical cyclone threat axis for the month of June. The area within the arrow approximates a 30% or greater probability of a tropical cyclone coming within 180 n mi of Sasebo (hatched area). Displacement of the arrowhead center east or west of Sasebo indicates a greater tendency for tropical cyclone passage on the corresponding side. Approach times to Sasebo are based on Table 2, Section 5.1.

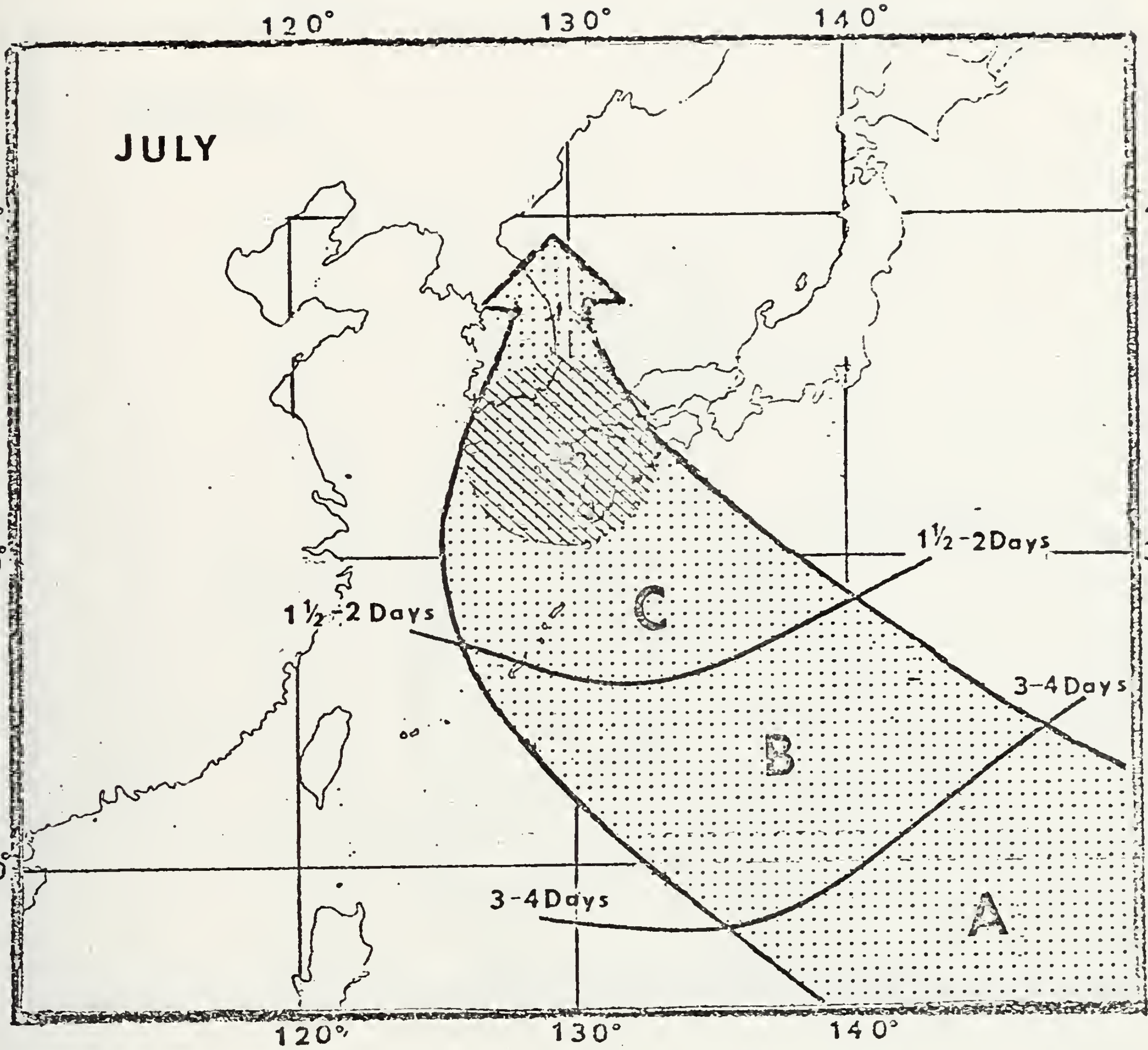

Figure 28. Tropical cyclone threat axis for the month of July. The area within the arrow approximates a 30% or greater probability of a tropical cyclone coming within 180 n mi of Sasebo (hatched area). Displacement of the arrowhead center east or west of Sasebo indicates a greater tendency for tropical cyclone passage on the corresponding side. Approach times to Sasebo are based on Table 2, Section 5.1.

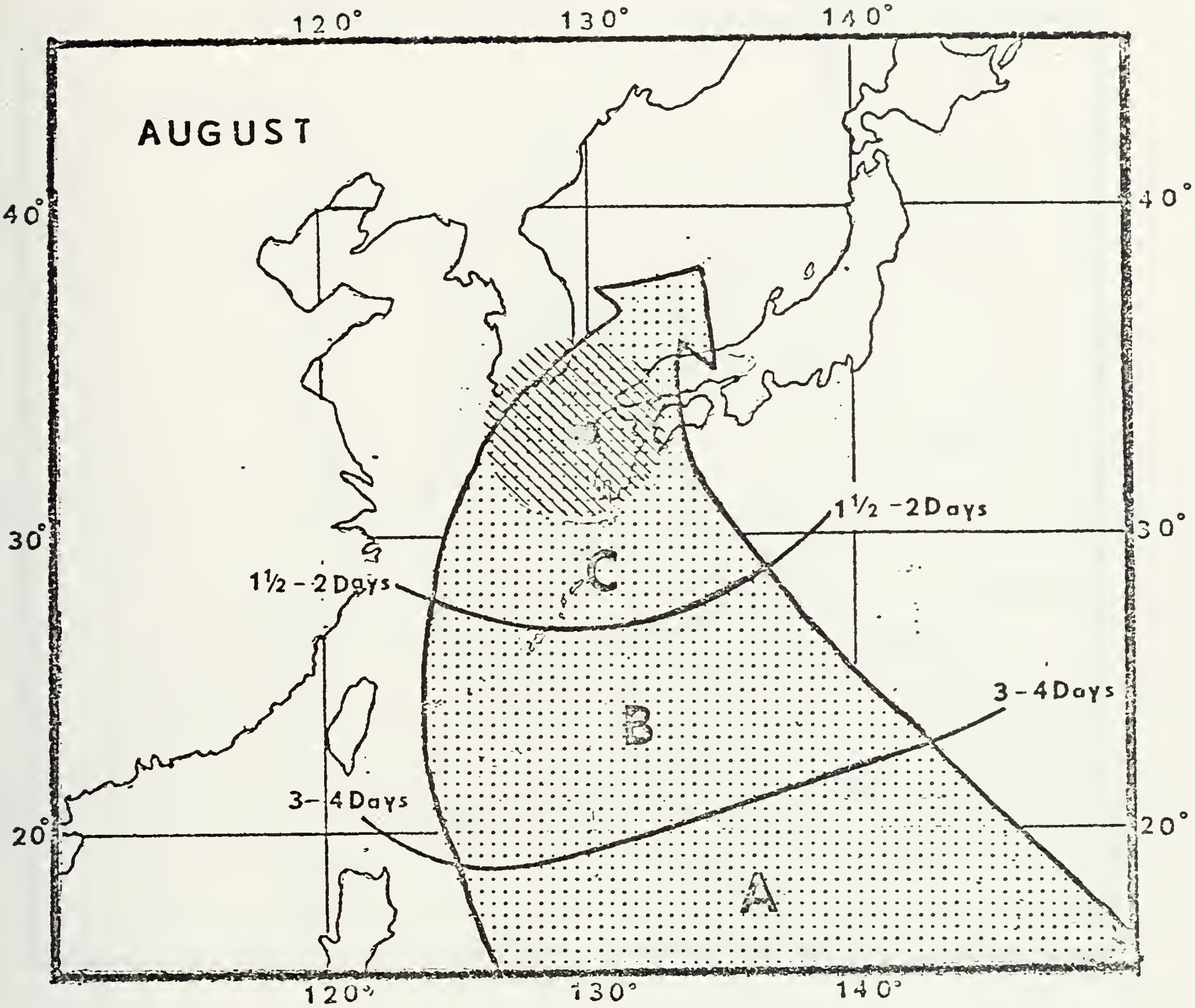

Figure 29. Tropical cyclone threat axis for the month of August. The area within the arrow approximates a 30% or greater probability of a tropical cyclone coming within 180 n mi of Sasebo (hatched area). Displacement of the arrowhead center east or west of Sasebo indicates a greater tendency for tropical cyclone passage on the corresponding side. Approach times to Sasebo are based on Table 2, Section 5.1.

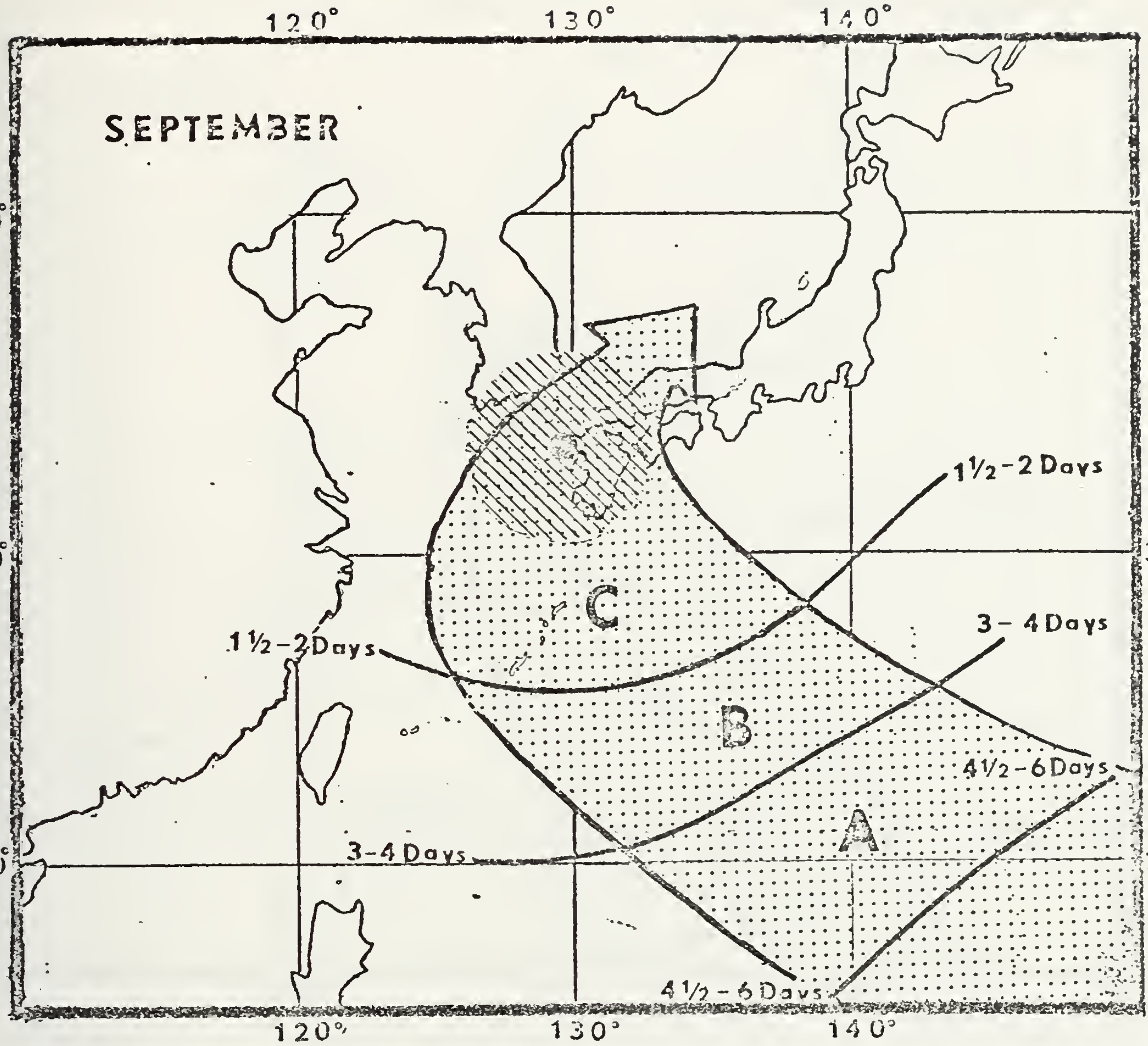

Figure 30. Tropical cyclone threat axis for the month of September. The area within the arrow approximates a 30% or greater probability of a tropical cyclone coming within 180 n mi of Sasebo (hatched area). Displacement of the arrowhead center east or west of Sasebo indicates a greater tendency for tropical cyclone passage on the corresponding side. Approach times to Sasebo are based on Table 2, Section 5.1.

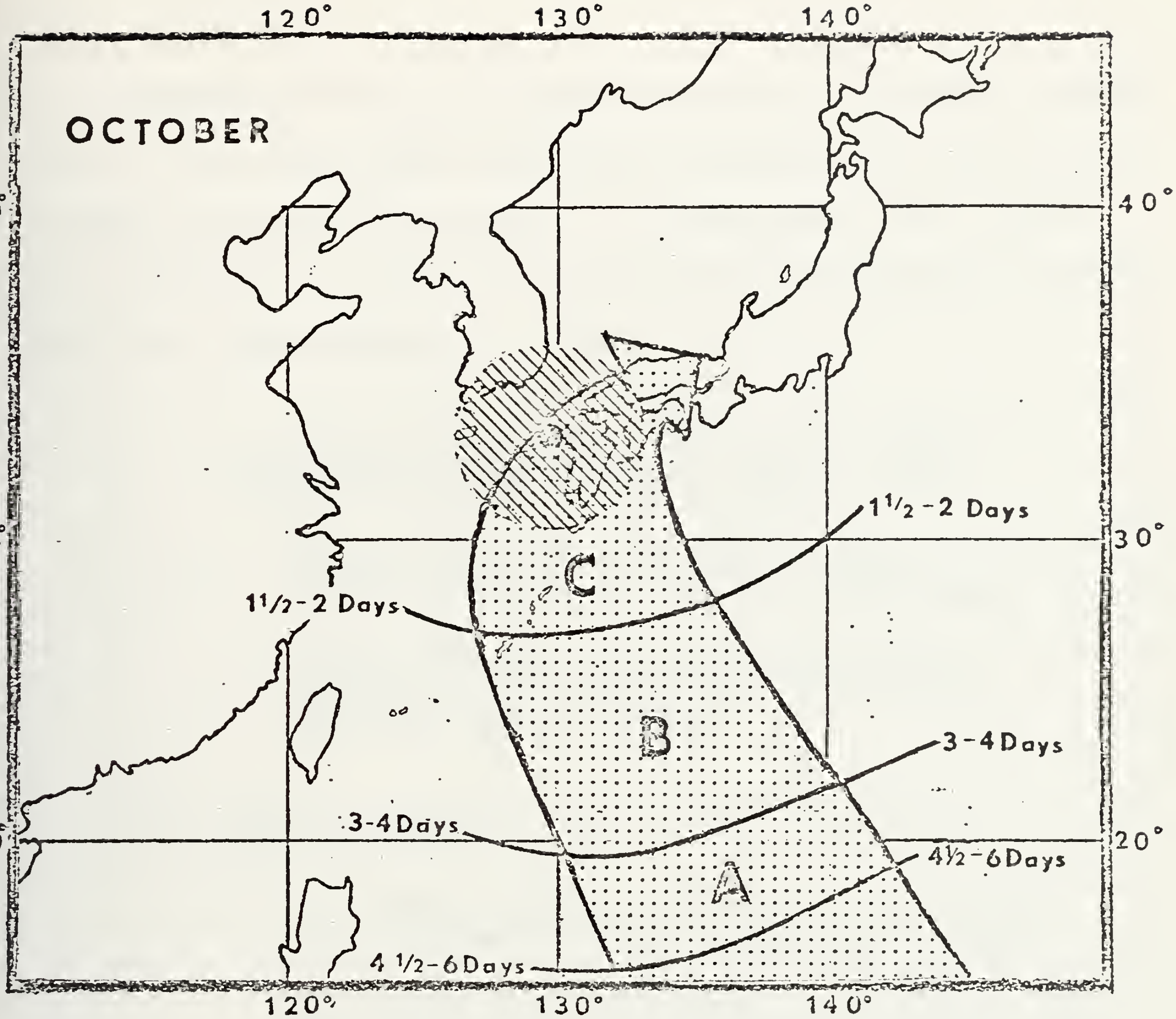

Figure 31. Tropical cyclone threat axis for the month of October. The area within the arrow approximates a 30% or greater probability of a tropical cyclone coming within 180 n mi of Sasebo (hatched area). Displacement of the arrowhead center east or west of Sasebo indicates a greater tendency for tropical cyclone passage on the corresponding side. Approach times to Sasebo are based on Table 2, Section 5.1.

6.3 EVASION

Evasion at sea is recommended only for aircraft carriers. Since the waters near Sasebo Harbor are restricted, evasion must commence early. To facilitate early action, the following timetable (in conjunction with Figures 27-31) has been established:

I. An existing tropical cyclone moves into or development takes place in area "A" with forecast movement toward Kyushu:

   a. Review material condition of ship. A sortie may be desirable 2-4 days hence.

   b. Reconsider any maintenance that would render the ship incapable of getting underway within 48 hours.

II. Tropical cyclone enters area "B" moving toward Sasebo:

   a. All ships begin planning course of action to be taken if sortie should be ordered.

   b. Reconsider any maintenance that would render the ship incapable of getting underway within 24 hours.

III. Tropical cyclone enters area "C" moving toward Sasebo:

   a. Execute sortie plans made in previous steps.

If possible, evasion to Yokosuka Harbor, a designated aircraft carrier haven, should be considered first. Evasion routes at sea may be developed by the use of Appendix A (the mean tropical cyclone tracks, track limits, and average speed of movements for the months June-October in conjunction

with Figures 27 - 31 (tropical cyclone threat axis and approach times to Sasebo for the months June-October). In all cases, Optimum Track Ship Routing (OTSR) should be consulted as to the best evasion route.

In planning an evasion route, it must be noted that the Sea of Japan, the Yellow Sea and the East China Sea are restricted by land masses and are frequented by tropical cyclones during 1 July - 10 September to make evasion to those seas difficult. Also, destructive seas have been noted to develop rapidly in the shallow waters of the East China Sea.

7. CONCLUSIONS

The conclusion reached by this study is in full agreement with the previous study by Fleet Weather Facility, Yokosuka (1967) which considered Sasebo Harbor to be a favorable typhoon haven for all ships except aircraft carriers. The following reasons were used in arriving at this conclusion:

1. The harbor topography provides excellent protection from winds out of the north or east and good protection from southerly winds. However, due to the large "sail area" of a carrier, winds may affect the ship severely.

2. The anchor holding action in the typhoon anchorage is excellent.

3. There is sufficient maneuvering room while at typhoon anchorage in the outer harbor. However, aircraft carriers may be too restricted if many ships are present.

4. The inner harbor provides little protection for aircraft carriers. Ships of the size of AR's, AOE's, and AF's can find good protection at India Basin, Berths 8 and 9. Small ships have excellent protection in wet drydocks.

5. Surge effect is minimal and wave action is not excessive during the passage of a typhoon.

6. Port services available are excellent.

To aid commanding officers in rapidly evaluating the threat posed to Sasebo by an individual tropical cyclone, and to aid in the decisions thereafter, Figure 32 has been incorporated into this text.

TROPICAL CYCLONE DEVELOPMENT IN WESTPAC

To determine whether tropical cyclones will or will not affect the area within 400 n mi of Sasebo, refer to:

a. Section 6.1 (p. 56) which describes tropical cyclone warning information. Examine present warnings.

b. Monthly mean western North Pacific climatological typhoon tracks in Appendix A (pp. 71-84).

c. Section 5 (pp. 26 - 55)-tropical cyclone climatology for Sasebo. In particular, Figures 14-18 (pp. 36-40), the percent threat analyses, and Figures 19-24 (pp. 42-47), the tracks of gale associated storms.

WILL AFFECT SASEBO

WILL NOT AFFECT SASEBO

AL CYCLONE WILL AFFECT THE
ITHIN 400 N MI OF SASEBO

) determine whether the tropical
: will pose a threat (pass within
ii) to the port refer to:

Section 6.1 (p. 56) which de-
; tropical cyclone warning informa-
ailable. Examine present warnings
ssued.

Figures 19-24 (pp. 42-47) the
of gale associated storms.

Section 5.1 (pp. 26-35) and
1 5.2 (pp. 41-53) with emphasis
ire 25 (p. 51) for the position
storm centers when ≥ 22 kt
egan at Sasebo and Figure 26
for the position of past storm
when ≥ 34 kt began at Sasebo.

TROPICAL CYCLONE WILL NOT AFFECT THE AREA WITHIN 400 N MI OF SASEBO

Continue to monitor storm movement; be alert for significant changes.

NO THREAT TO SASEBO

TROPICAL CYCLONE IS NOT A THREAT TO SASEBO

Continue to monitor storm movement be alert for significant changes.

THREAT TO SASEBO

TROPICAL CYCLONE WILL POSE A THREAT TO SASEBO

REMAINING IN PORT

naining in port is the recommended procedure
r all ships except aircraft carriers. Refer
:

a. Section 6.2 (p. 57), "Remaining in Port".

b. Section 4, "Sasebo" with emphasis on harbor characteristics, Section 4.2 (p. 21), Topography, Section 4.3 (p. 23) and Harbor Facilities, Section 4.4 (p. 25).

c. Appendix E (p. 105) especially comments by commanding officers while in port during typhoon passage.

EVASION

Evasion is not recommended except for aircraft carriers. Refer to:

a. Appendix A (p. 71), Mean Western North Pacific Typhoon Tracks.

b. Section 6.2 (p. 57) with emphasis on Figures 27-31 (p. 60-64).

c. Section 6.3 (p. 65), Evasion.

d. Consult OTSR.

Figure 32. Decision Flow Diagram.

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APPENDIX A

The mean typhoon tracks, track limits and average speed of movements for the month of June and in ten-day periods for July-October are depicted in Figures A1 - A13. It must be realized that storms deviate from the mean tracks, but about 80-90 percent will fall within the track limits. The use of these tracks should be of particular benefit in long range (in excess of 48 hours) planning. The application of average tracks to the short range specific situation should be avoided.

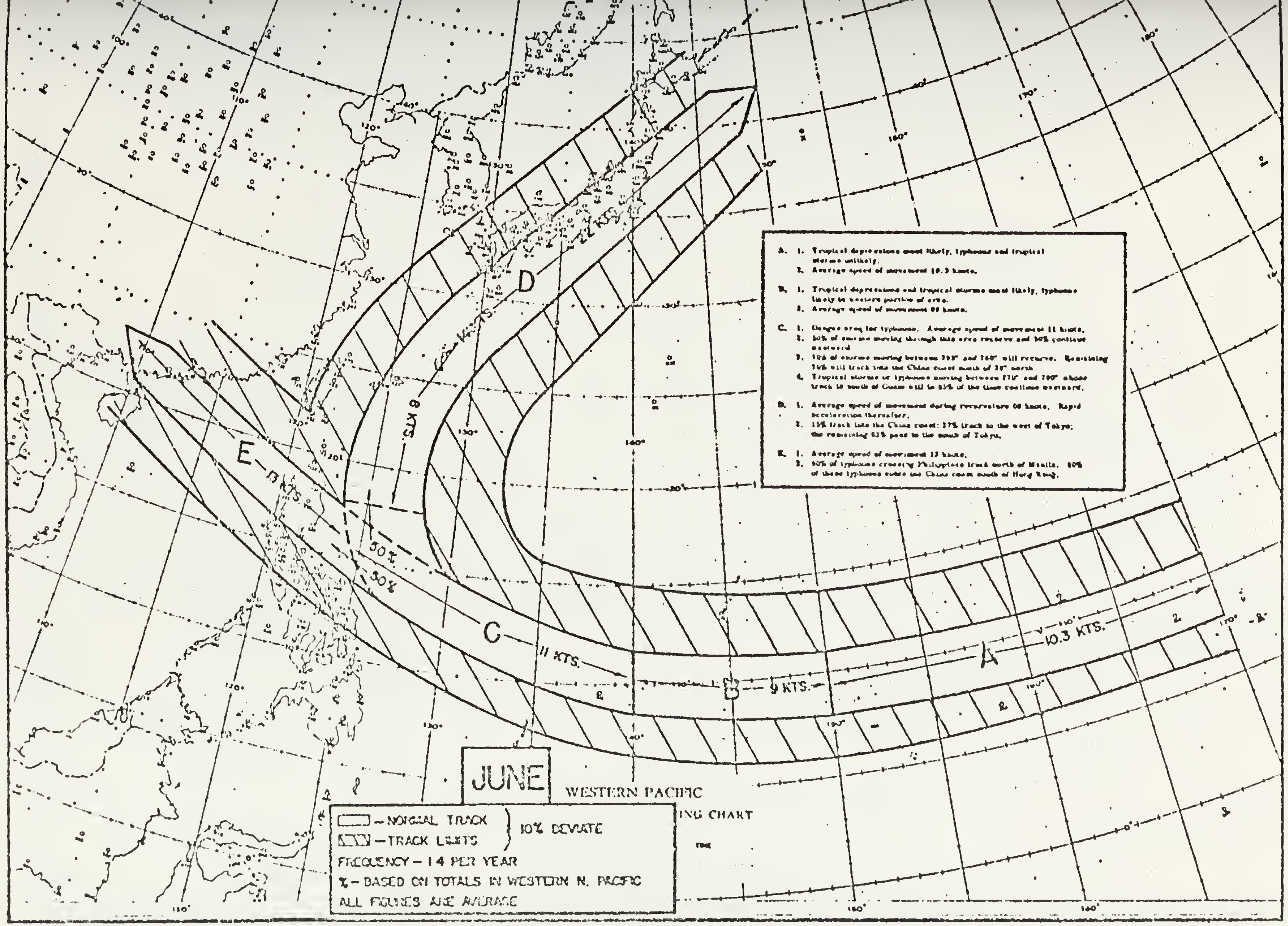

Figure A1. Mean typhoon tracks, track limits and average speed of movement for the month of June.

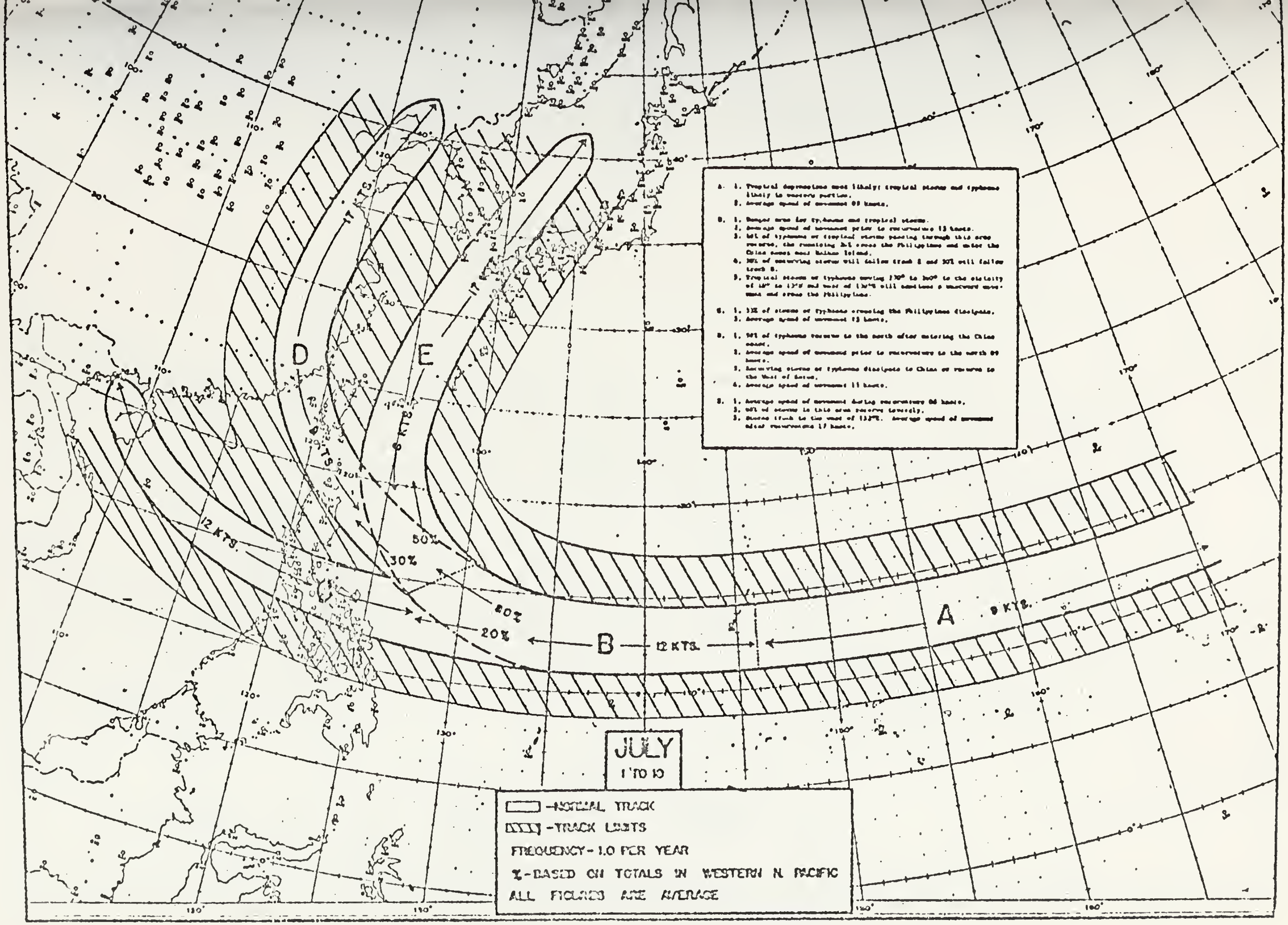

Figure A2. Mean typhoon tracks, track limits and average speed of movement for 1 - 10 July.

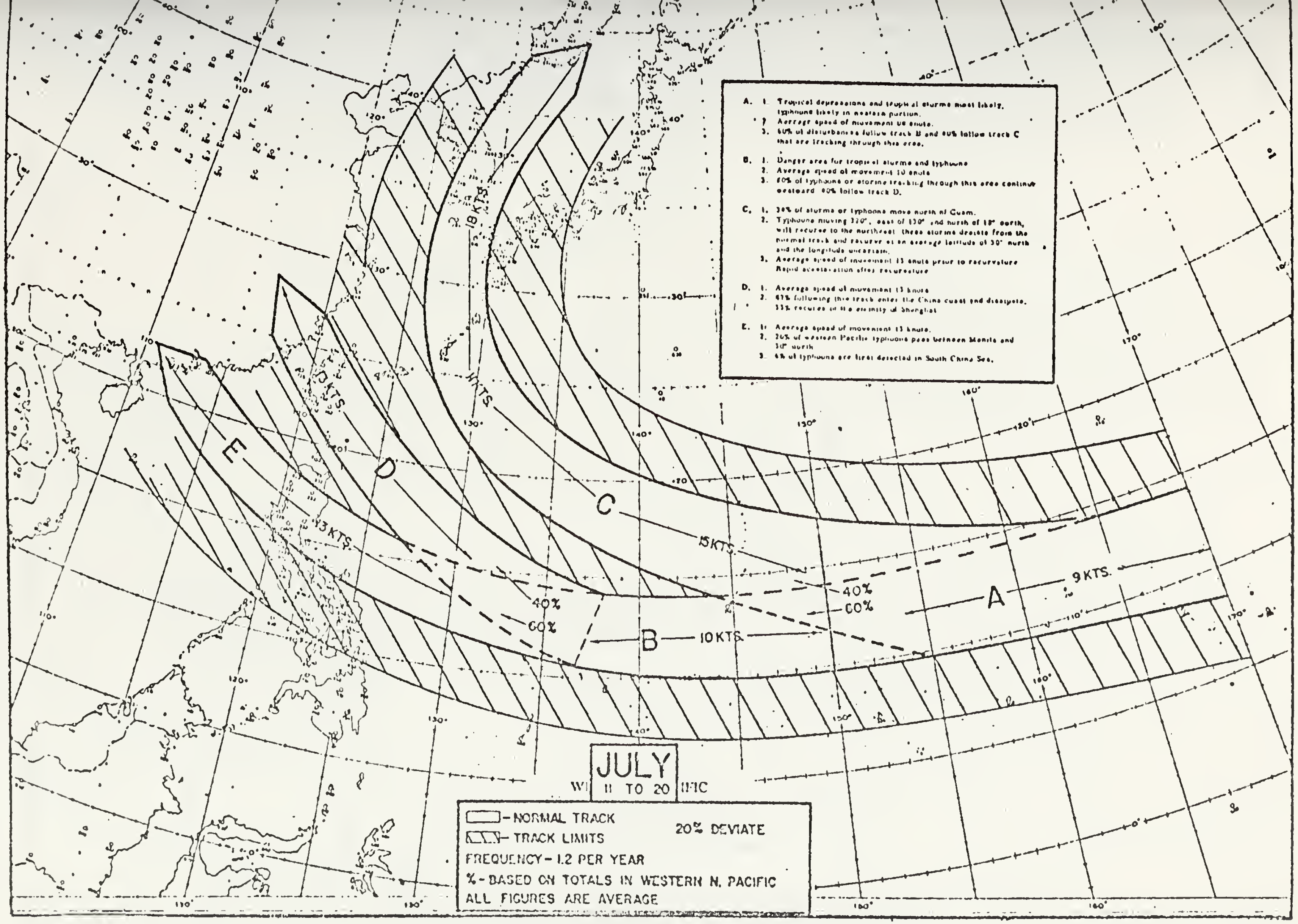

Figure A3. Mean typhoon tracks, track limits and average speed of movement for 11 - 20 July.

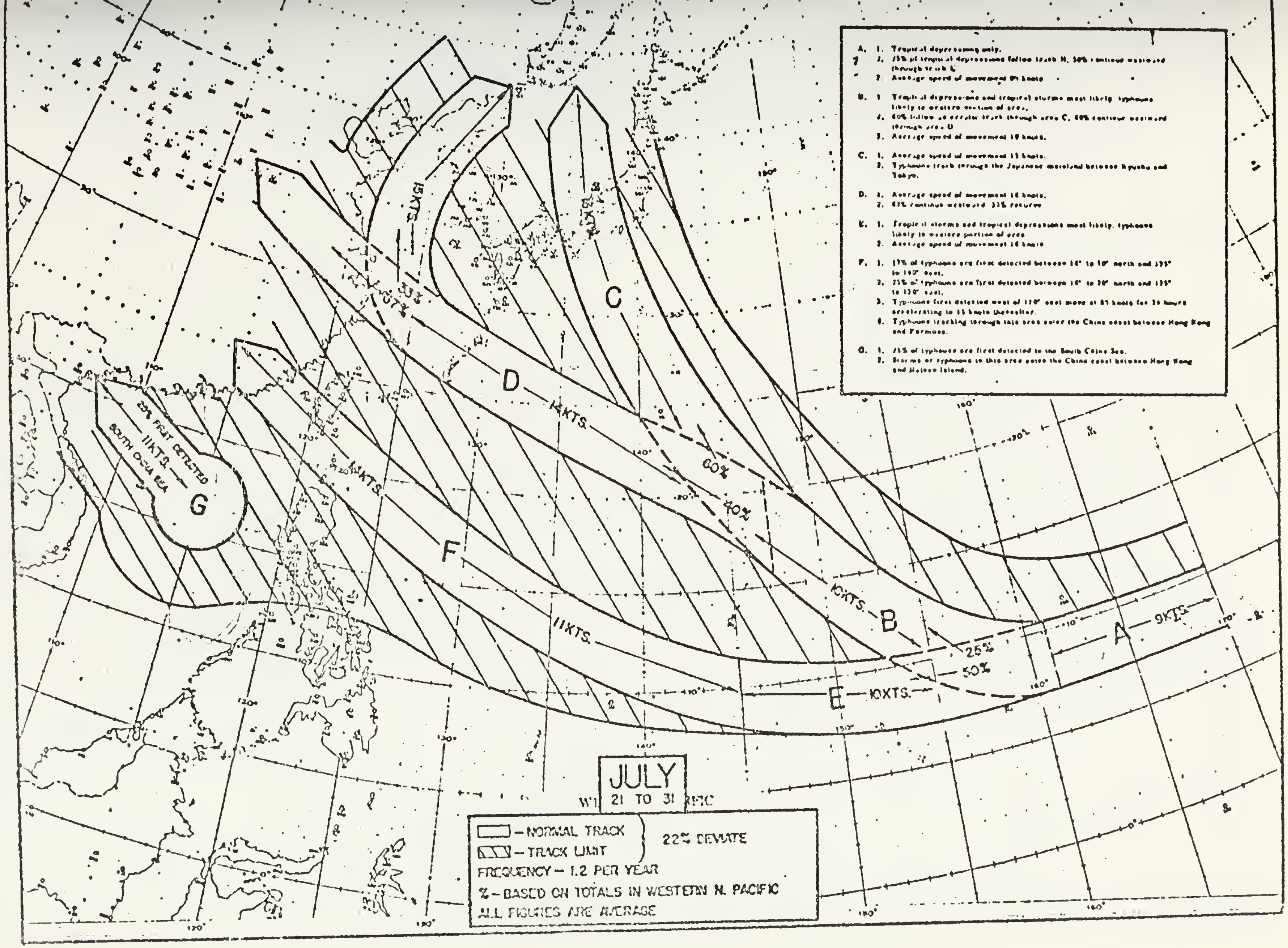

Figure A4. Mean typhoon tracks, track limits and average speed of movement for 21 - 31 July.

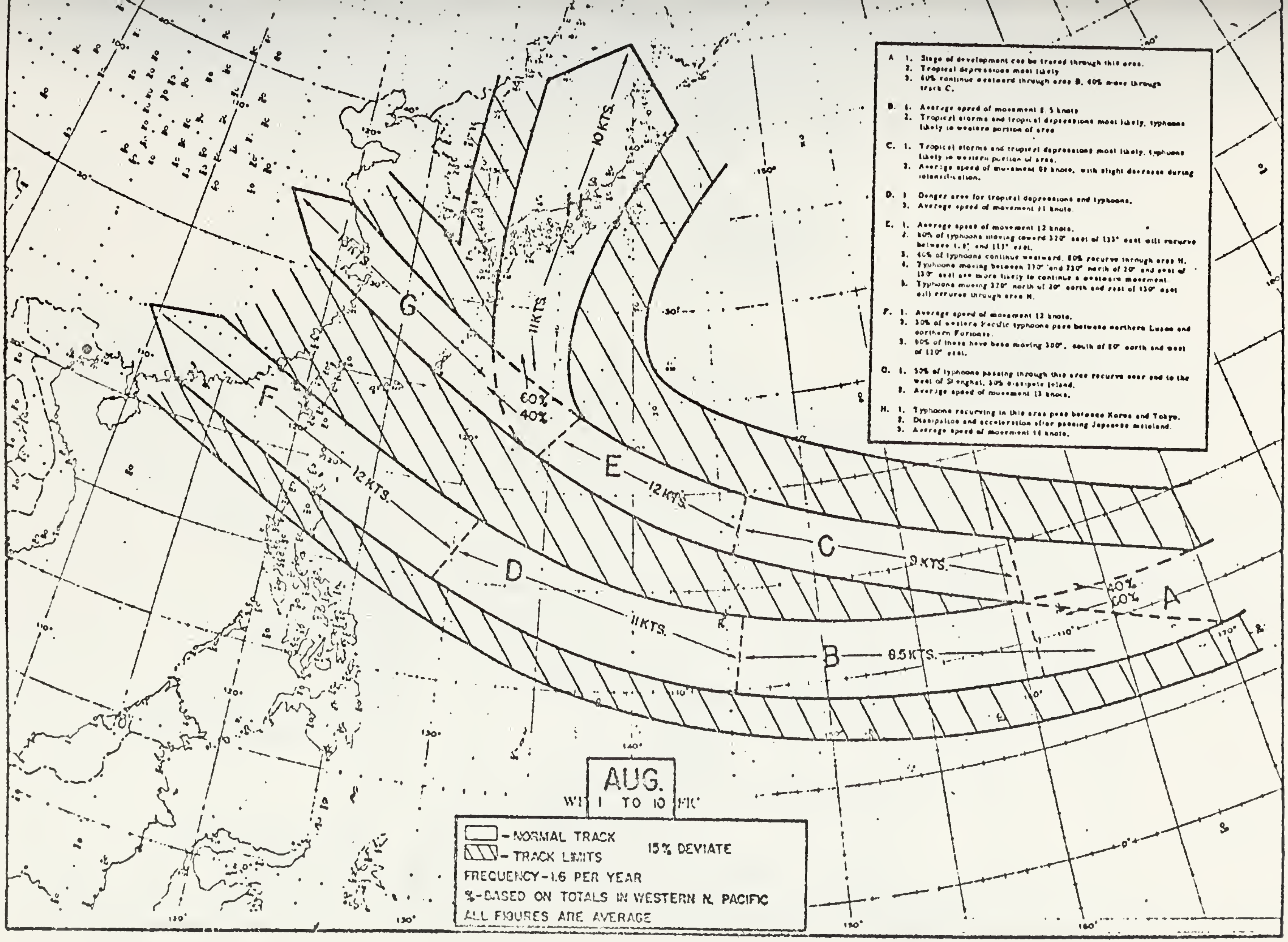

Figure A5. Mean typhoon tracks, track limits and average speed of movement for 1 - 10 August.

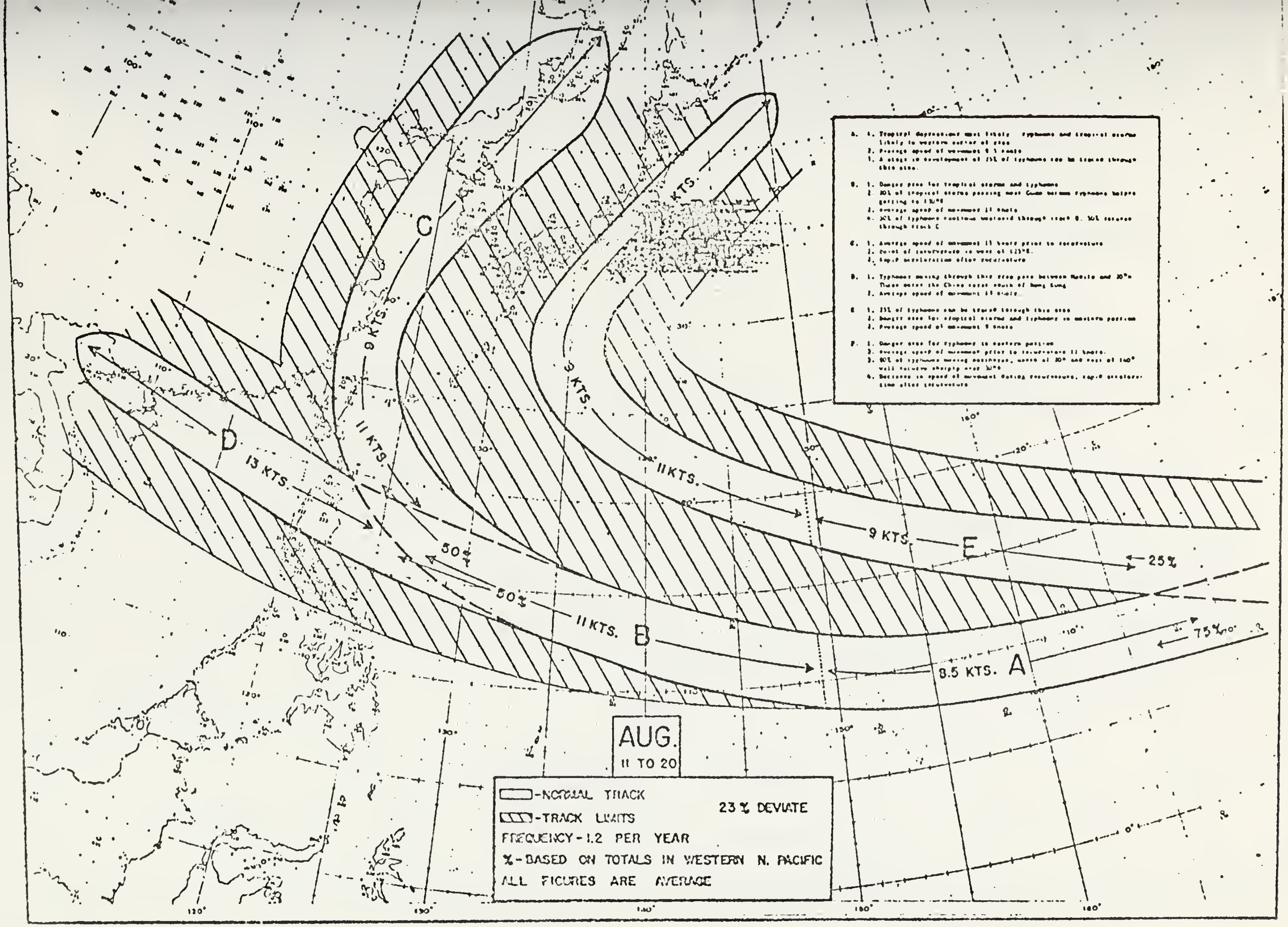

Figure A6. Mean typhoon tracks, track limits and average speed of movement for 11 - 20 August.

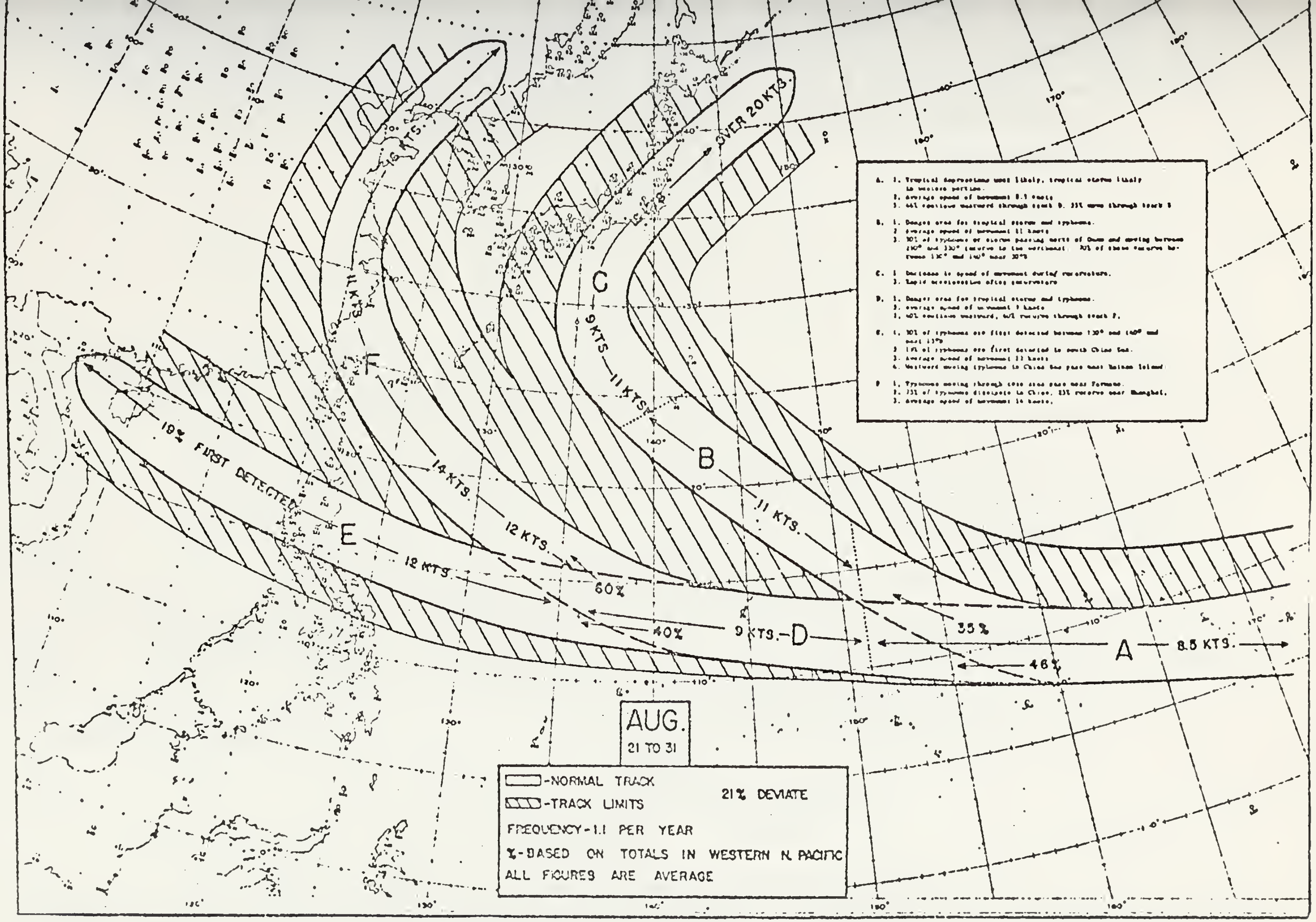

Figure A7. Mean typhoon tracks, track limits and average speed of movement for 21 - 31 August.

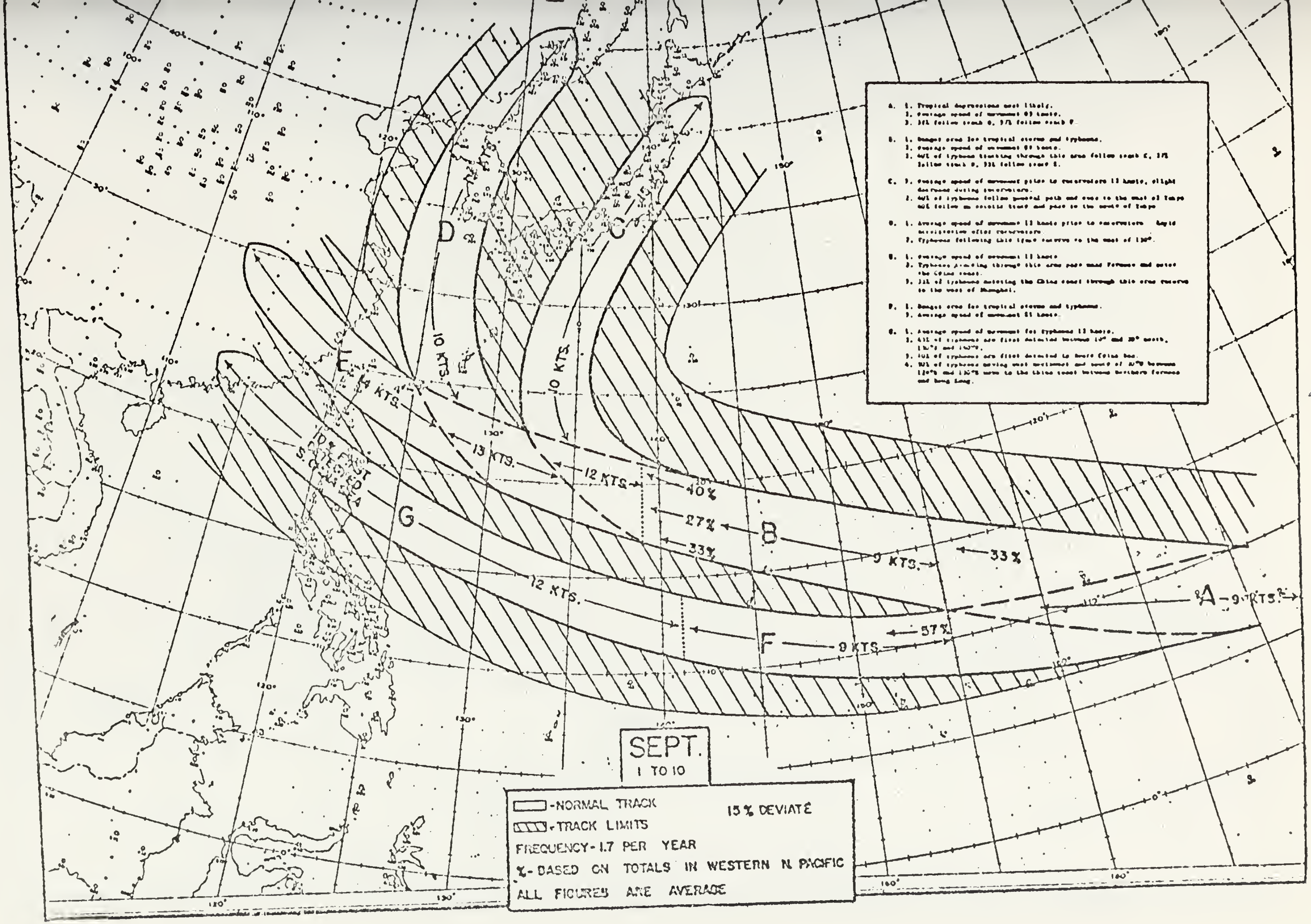

Figure A8. Mean typhoon tracks, track limits and average speed of movement for 1 - 10 September.

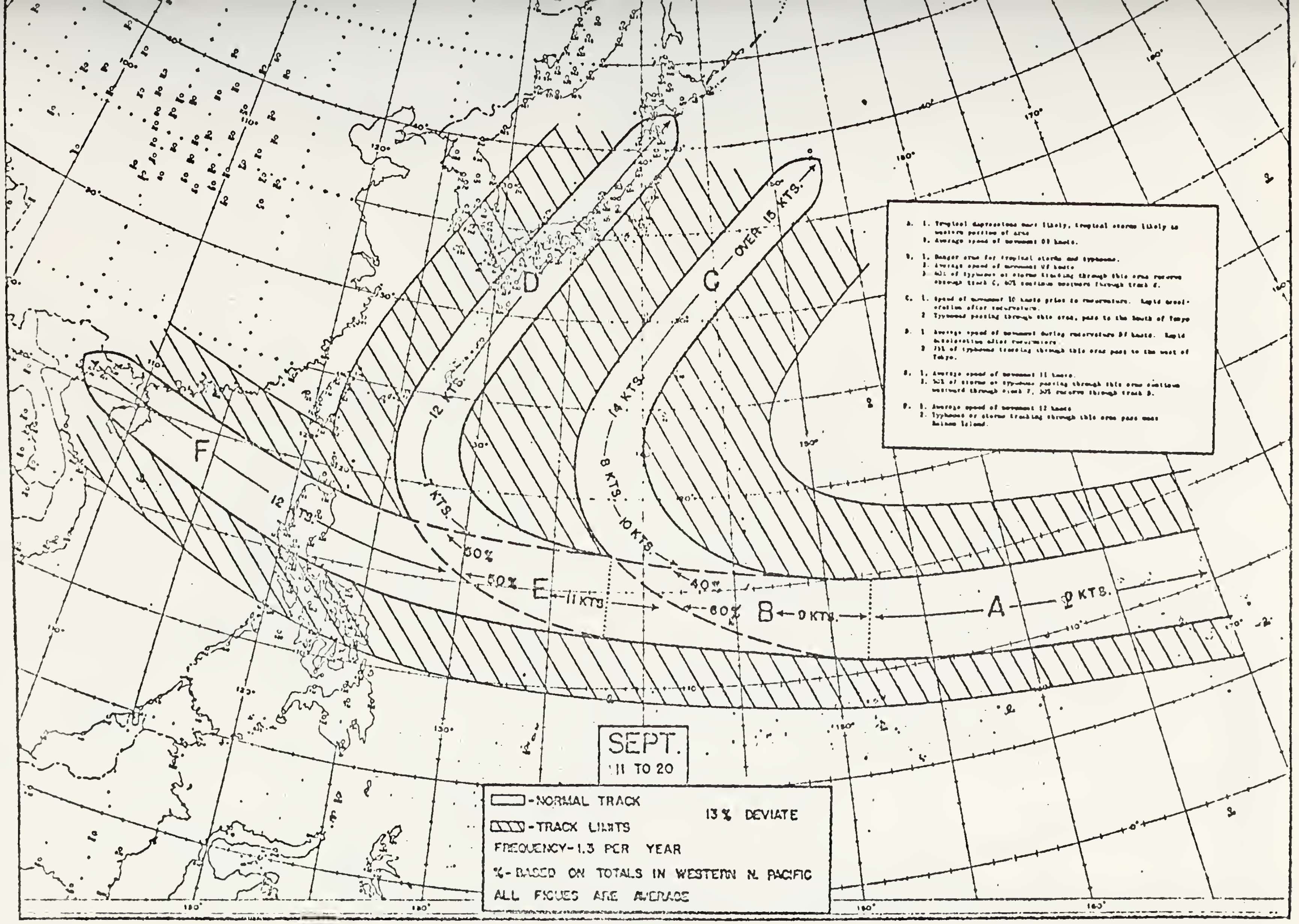

Figure A9. Mean typhoon tracks, track limits and average speed of movement for 11 - 20 September.

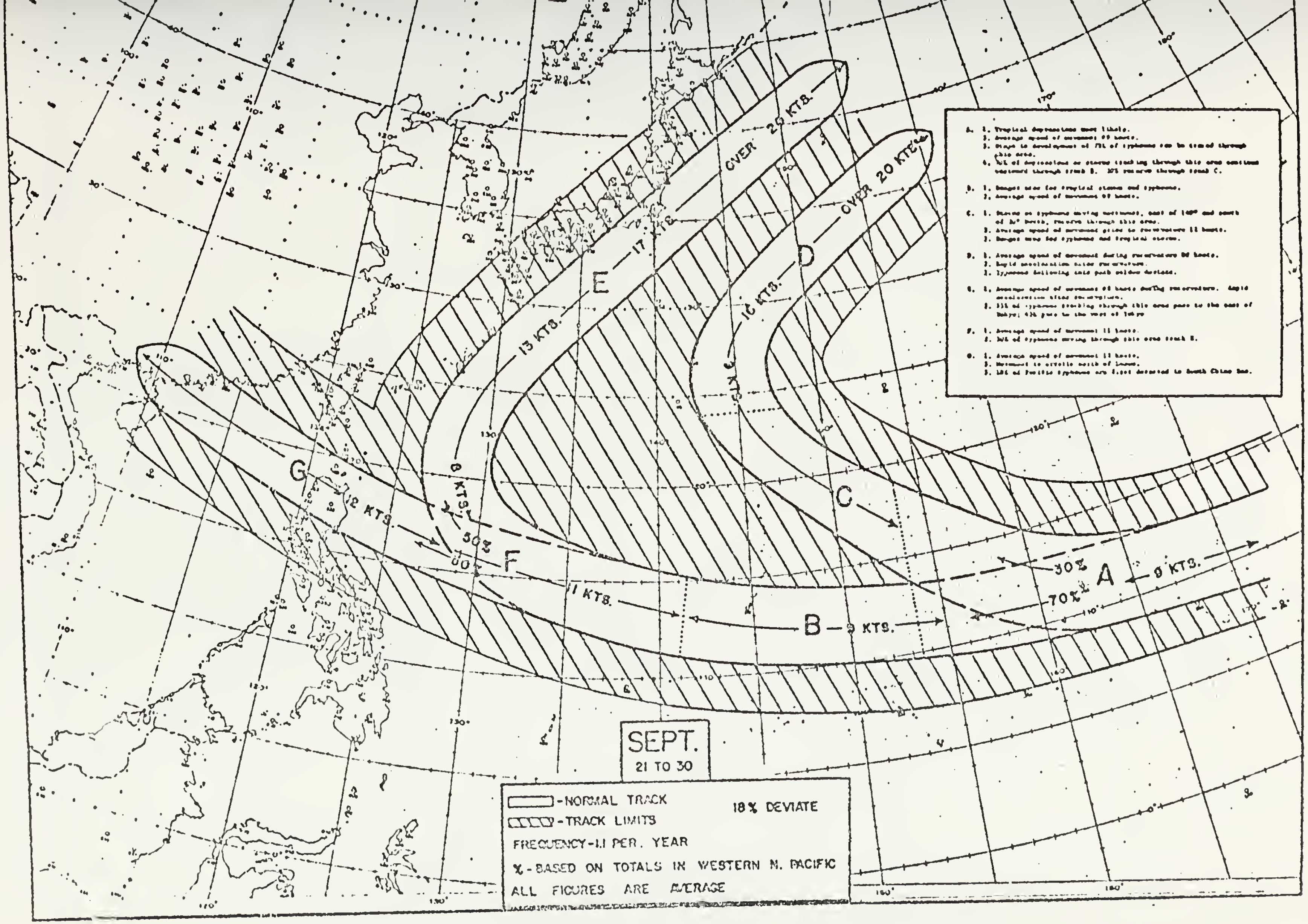

Figure A10. Mean typhoon tracks, track limits and average speed of movement for 21 - 30 September.

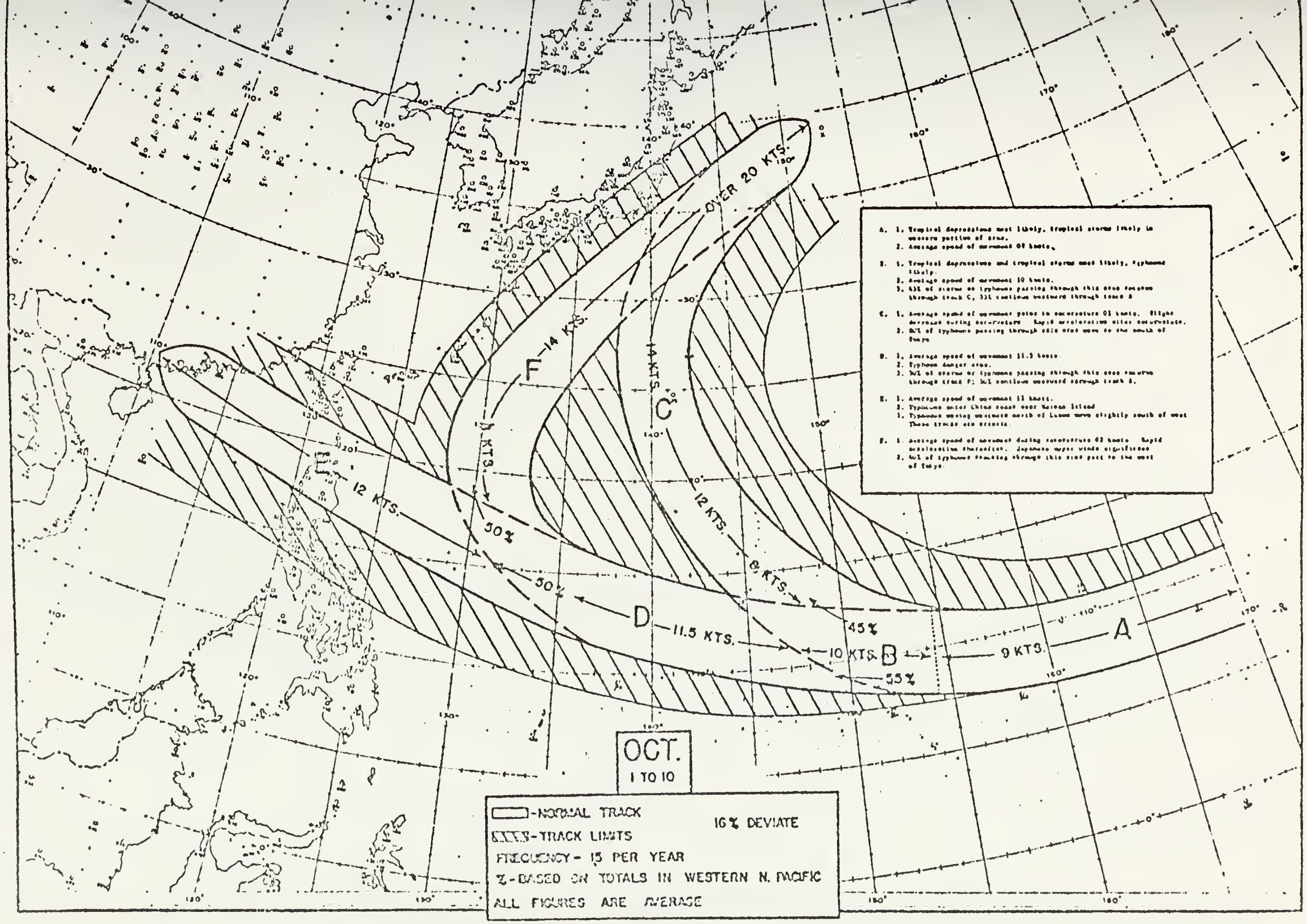

Figure A11. Mean typhoon tracks, track limits and average speed of movement for 1 - 10 October.

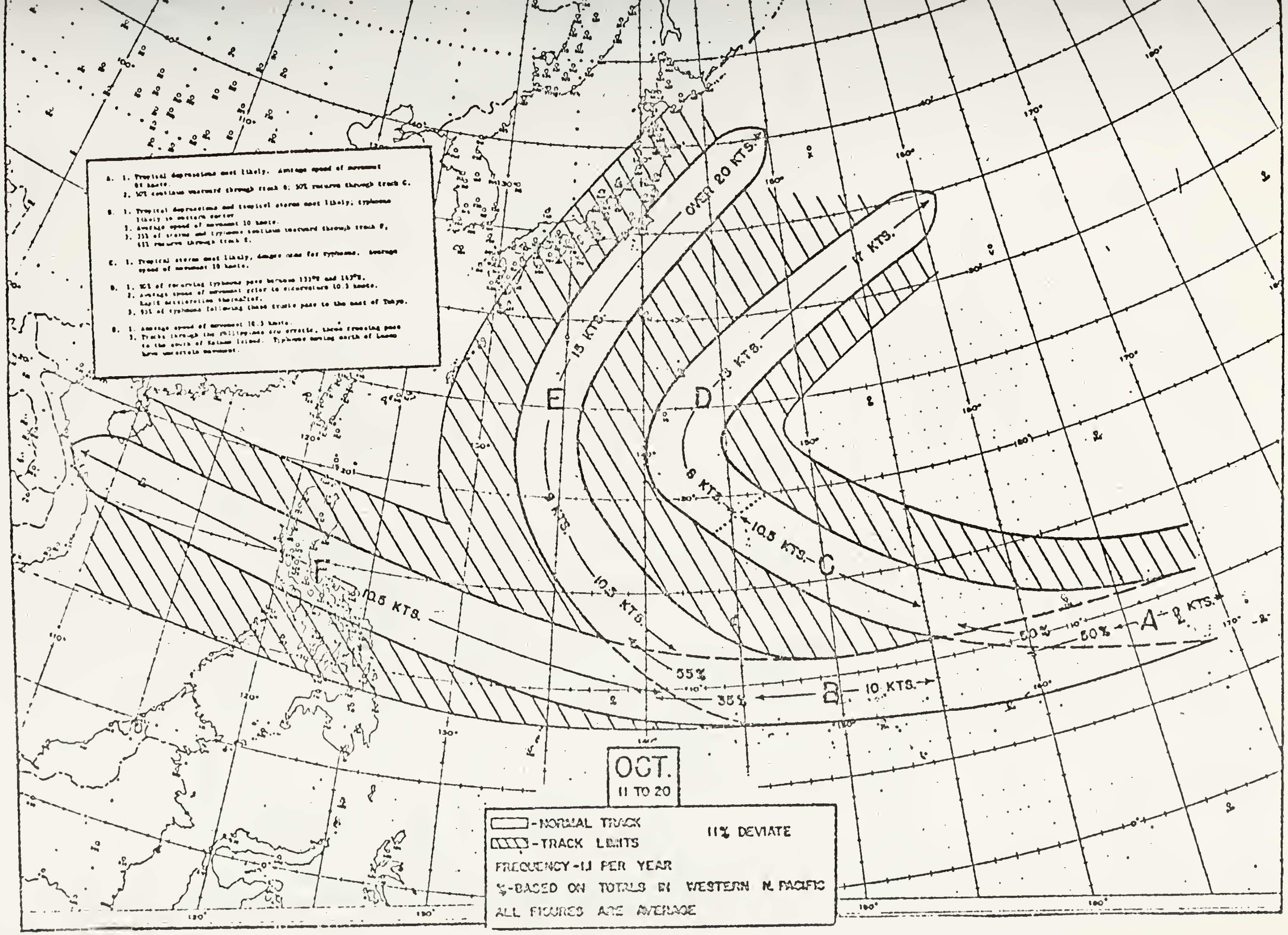

Figure A12. Mean typhoon tracks, track limits and average speed of movement for 11 - 20 October.

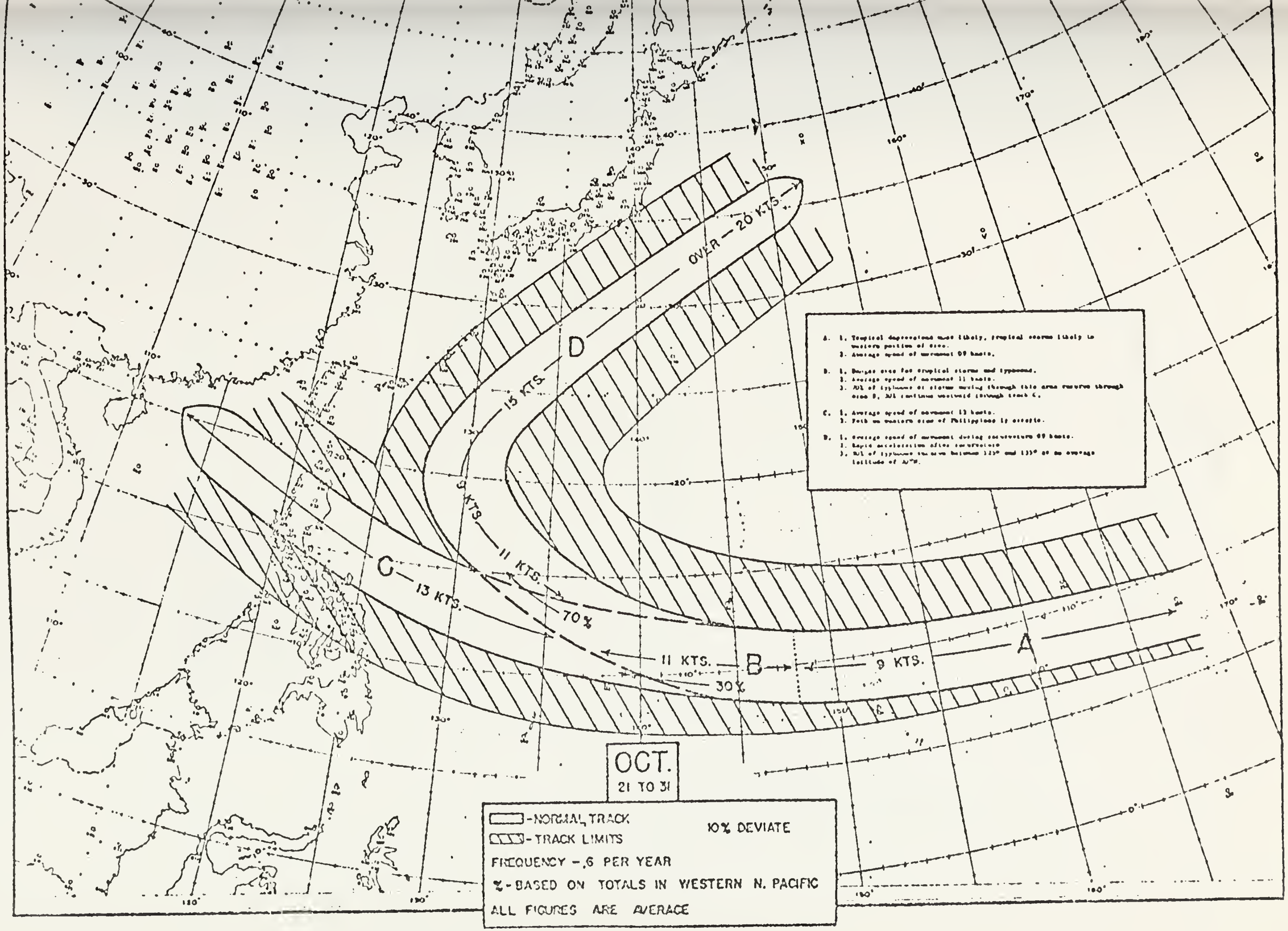

Figure A13. Mean typhoon tracks, track limits and average speed of movement for 21 - 31 October.

APPENDIX B

Sasebo Harbor Facilities

The following is a list of piers, buoys and other equipment available in Sasebo Harbor:

* MOORING BUOYS

Number	Ship Type	Capacity Tons
1N	CA, CL, AO, Repair & Cargo	30,000
1S	"	10,000
3	"	10,000
7	"	10,000
8	"	10,000
15	"	30,000
20	"	30,000
21	BB, CVA, CA, AO, Repair & Cargo	30,000
22	"	10,000
60	Ammunition Ships	18,000
61	"	12,000
62	"	12,000
63	"	12,000

* Mooring buoys are being removed/relocated. Fleet activities Sasebo will have up-to-date information on this.

TUGS

One 2,000 HP YTB
One 740 HP SSK
Two 540 HP SSK
One 1,200 HP YTM
One 960 HP YTM
Five 550 HP LCM

PIERS/WHARFS

				Berth Accommodations		
Name	Length	Width	Depth	Gross Tons	Berths	Notes
India Basin	5,400'	Unlimited	32'-35'	-	8	Lights, potable water
Hario Dock	262'	82'	30'	LST	7	Ammunition dock
Maebata	196'	22'	17'	-	-	-

POL FACILITIES.

Name	Length	Controlled Draft	Mean Draft	Hose Connection	Product
Akasaki #1	557'	40'	42'	2" x 8"	NSFO
#2	557'	40'	41'	2" x 8"	NSFO
				1" x 6"	MOGAS
				1" x 6"	DFM
				1" x 6"	AVGAS
Akasaki #3	557'	39'	47'	4" x 8"	NSFO
				8" x 8"	JP-4
				4" x 8"	Multi
Motofune #1	263'	34'	42'	4" x 8"	MOGAS
				1" x 8"	NSFO
				5" x 8"	Multi
Motofune #2	263'	32'	40'	4" x 8"	NSFO
				4" x 8"	Multi
Irozaki (M)	266'	31'	39'	3" x 8"	DFM
				3" x 8"	JP-5
				5" x 8"	JP-5
Irozaki Jetty	80'	20'	28'	1" x 6"	DFM
Yokose	264'	45'	48'	6" x 8"	NSFO
				4" x 8"	AVGAS
				4" x 8"	JP-5

HANDLING EQUIPMENT. Several floating and rail mounted cranes are available from Sasebo Heavy Industries (SSK) with capacities from 10 to 150 tons.

Cranes	Number	Capacity Life	Notes
Shore	2	one 15 tons and one 250 tons	USN at India 5, 7 and 8
Floating			
Self-propelled	1	150 tons	USN
Non-self-propelled	2	30 tons	USN
Mobile	6	7.5 tons to 50 tons	USN

SHIPYARD AND DRYDOCKS

Name	Length	Width	Depth	Capacity	Height	Notes
No. 1	514'	87'	42'	8,000 GT	-	Two mobile cranes
No. 2	106'	107'	47'	26,000 GT	-	USN
No. 3	1,214'	230'	49'	180,000 GT	-	Two 15 ton cranes
No. 4	1,115	168'	54'	80,000 GT	-	Four 20 to 60 ton cranes
No. 5	464'	99'	38'	6,000 GT	-	One 20 ton crane
No. 6	591'	96'	43'	13,000 GT	-	One 20 ton crane

APPENDIX C

Calculating the danger area (from CINCPACFLT OPORD 201-YR) and Heavy Weather Plan from SOPA (ADMIN) Sasebo INST 5000.1 Series.

(2) Calculating Danger Area. Although forecast accuracy is improving, the average Joint Typhoon Warning Center 24 hour typhoon forecast error, derived from statistics over past years, is about 135 miles. Tropical cyclone warnings issued by the Joint Typhoon Warning Center, Guam, now contain 24 hour forecasts of peripheral winds greater than 50 knots and greater than 30 knots winds associated with a tropical cyclone. Should conditions of fetch and duration obtain, 30 knot winds are capable of producing a fully arisen sea with waves up to 28 feet. The nonexactness of center position reports and the fact that a typhoon often follows an erratic track have led to the evolution of rules for avoiding the destructive winds (greater than 30 knots) in the typhoon circulation. Figure 1 is one scheme for avoiding the winds and seas associated with typhoons.

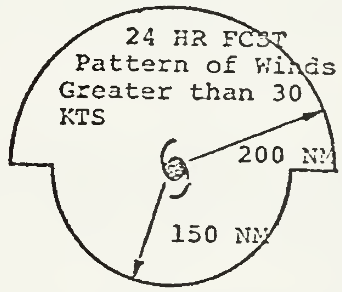

Figure 2

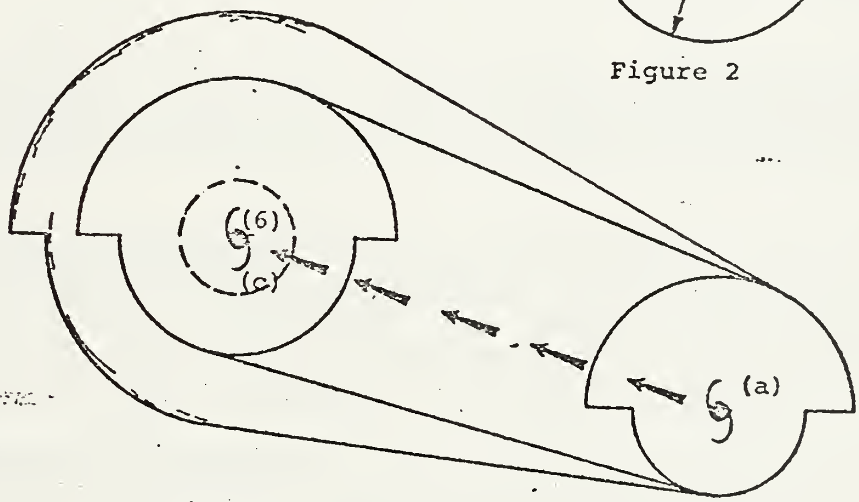

Figure 1

As each new warning is received:

(a) Mark the reported center position of the tropical cylone.

(b) Mark the 24 hour forecast center position of the cyclone.

(c) Draw a line from point (a) to point (b) indicating the forecast track.

(d) Using a radius of 135 miles draw a circle around the forecast center. This will enclose a locus area of possible 24 hour center positions.

(e) Extract the 24 hour forecast for winds greater than 30 knots. For example this might read, "RADIUS OF OVER 30 KT WIND: 24HRS VALID 021700Z 200 NM NORTH SEMICIRCLE 150 NM SOUTH SEMICIRCLE."

(f) Using a template or mechanical drawing compass lay off the locus of the limiting area of 24 hour forecast of winds greater than 30 knots (Fig. 2) by placing the center of the south oriented wind pattern along the perimeter of the 24 hour locus of possible center locations. A practical approximation would be simply to add 135 miles to the forecasted wind radii.

(g) Draw the envelope connecting the points of maximum extent of the 30 hot winds. The resultant enclosed area could very likely contain winds in excess of 30 knots within the next 24 hours. THE ENTIRE AREA IS TO BE AVOIDED.

(h) RECALCULATE THE DANGER AREA WITH EACH NEW WARNING RECEIVED

(3) Estimating Danger Area.

(a) Locating the ship relative to the dangerous and navigable semicircles t initiate evasion procedures is a continuing problem. Revision and updating of te typhoon's forecast movement may completely change the spatial relationship of sip to typhoon center. When still well in advance of the typhoon circulation, refully plotting each new warning, ships should maneuver to avoid adverse winds al seas. However, changing course and speed to cross the forecast track of a phoon in order to reach the navigable semicircle (TAB C) is considered extremely ngerous once the ship is located within the area of greater than 30 knots winds sociated with the typhoon.

(b) In event that the center position of a typhoon is not available, h direction can be estimated as follows: "Face the wind. The bearing of the torm center is then 100 to 130 degrees to your right." Care should be taken not use a wind direction during a squall, for the wind may be non-representative. ager allowance in degrees should be made in the rear of a typhoon than in the ont.

(c) A ship equipped with radar which is capable of giving a return rm precipitation may be able to use it to advantage if near the storm. Attenaion of the signal by precipitation may cause the scope picture to be deceptive. o this reason the established methods of maneuvering in the vicinity of a typhoon ut not be ignored.

e. Riding Out a Typhoon. When impossible to avoid the typhoon associated 30 nt winds standard rules serve as a guide. These depend on the ship's estimated oition with relation to the track of the typhoon. Position with respect to the yhoon circulation depicted ideally in Tab C can be estimated by plotting the hp's position with respect to the forecast track and danger area depicted in iure 1.

(1) When on Track of Typhoon. If the barometer continues to fall and the ind direction remains constant or veers clockwise slowly and increase in inteni', the ship is on or near the track of the typhoon. In this case, bring the ind to the starboard quarter, note the course, hold it and run for the "navigable" micircle. As long as the wind direction remains constant or veers slowly, the hi is in the path of the storm. When the wind has backed, or shifted counterlockwise, 15 degrees, the ship is entering the "navigable" semicircle.

(2) When in Dangerous Semicircle. If the ship is in the dangerous semirle, bring the wind on the starboard bow and hold it there. Make as much way he condition of the sea will allow. While maintaining this course, watch the n log carefully. If the wind veers (clock-wise), it indicates that you are in edangerous semicircle, so keep changing the course to hold the wind on the starad bow, and the typhoon will pass astern.

(3) When in the "Navigable" Semicircle. If it is estimated that the ship n the "navigable" semicircle, bring the wind on the starboard quarter, note ecourse, and hold it. If the wind backs (counter-clockwise) it means that the i is in "navigable" semicircle. If this course is held, the typhoon will pass tern. However, if the wind starts to veer (clock-wise) it means that you are in nerous semicircle rather than the "navigale" semicircle, and the course should hanged to follow the procedure described in subparagraph (2) above.

ANNEX W

HEAVY WEATHER PLAN

1. This plan establishes typhoon readiness doctrine and procedures for other hazards of nature or disaster and specifies minimum standards of safety to be observed by all ships present in Sasebo.

2. Basic Instructions.

a. Because of local topography Sasebo harbor provides excellent shelter during the passage of a typhoon to the east and good shelter during passage of a typhoon directly over or close to the west. Mooring buoy capacities and suitability of anchorages are adequate. Generally speaking, Sasebo harbor can be considered a typhoon haven for all but the largest of naval ships. The waters near Sasebo are so restricted that evasion by sorties must be commenced early.

b. Ordinarily SOPA will not order a general sortie from the harbor. CVA Task Groups usually sortie as a SEVENTH Fleet Task Group. Minecraft and towing and salvage types are much safer in port. Consequently SOPA Sasebo Typhoon Evasion Plans call for CVA Task Groups to act at the discretion of their commander and for small craft to remain in port. A sortie plan for other types will be promulgated when Typhoon Condition III is set. Task Group 96.6 organization assignments will be made to CVA/CVS/Minecraft/Tug types only when so requested.

c. The publication "Typhoon Havens Japan-Korea-Okinawa" produced by FLEWEAFAC Yokosuka in July 1967 provides background data for Sasebo Harbor.

d. Typhoon Evasion Plan.

(1) Upon sortie the Sasebo Typhoon Evasion Group Commander will originate a departure message to COMNAVFORJAPAN, information COMSEVENTHFLT SOPA and appropriate operational commanders, listing ships which have sortied in company, indicating point and time of departure plus anticipated track.

(2) Typhoon Evasion Groups and single ships departing to evade will advise COMNAVFORJAPAN, information to COMSEVENTHFLT, SOPA, and operation commander, of any significant changes in track specified in paragraph (1). If within the critical area, make reports directed in subparagraph 10.b. of Annex W.

(3) Make weather reports in accordance with COMSEVENTHFLT OPORD 201-YR, Annex W.

(4) Evasion Group/Unit Commanders and commanding officers of ships which have sortied singly shall report their return to port to COMNAVFORJAPAN, COMSEVENTHFLT and other interested commands.

(5) Task Organization.

(a) CTG 96.6, Evasion Group, Sasebo, SOPA Sasebo.

(b) TU 96.6, Large Auxiliary/Amphibious types/Senior unit commander/commanding officer.

(c) TU 96.6.2, Carriers/Cruisers.*

(d) TU 96.6.3, Minecraft/Towing and Salvage Types.**

* These units normally enter as part of a permanent task group and maintain their identity as such. Therefore, a 96.6 designator will only be assigned them upon request.

** These units will normally remain in port. Therefore, evasion task designators will be assigned only on request.

(6) Above evasion plan and task organization is always effective for planning and will be implemented on signal by SOPA Sasebo.

e. Merchant Ships. Commander Fleet Activities, as a matter of normal procedure, shall establish liaison with all merchant ships present and advise them of the nature of this plan.

f. Commanding Officers' Perogatives. Nothing in this plan shall be construed as abridging the right of a commanding officer to take action which he considers necessary to ensure the security of his command.

3. Storm Types.

a. Typhoons and Tropical Storms. Typhoons have been observed during each month of the year in the Western Pacific; those affecting Kyushu have in most cases occurred during the period 1 June to 1 December.

b. Storms and Gales. During the period from 1 October until 1 July, extra-tropical cyclones frequently move across Kyushu. Their approach is heralded by increasing southerly winds and as the associated cold front passes, a rapid wind shift to the north occurs accompanied by strong gusts sometimes reaching 65 knots.

c. Other Hazards of Nature or Disaster. Hazards of nature such as tidal waves, earthquakes, floods, seismic warnings, and other disasters will be dealt with on a case basis when occurring.

d. References. More detailed information regarding these weather types may be found in Bowditch's Practical Navigator and in Knight's Modern Seamanship. Typhoon evasion techniques are thoroughly discussed in Chapter II, PACFLT Supplement #1 to Shipboard Procedures (NWP 50A), and to COMSEVENTHFLT OpOrd 201-(YR).

4. Small Craft Warning. COMFLEACTS Sasebo will transmit the following message when winds of twenty knots occur in the harbor and when other weather conditions in the harbor make small boating hazardous:

"SMALL CRAFT WARNING COMMENCING ______. ANNEX W PARA 4 OF SOPA INST APPLIES".

a. Upon receipt of the above message, commanding officers of ships present will ensure that untended boats and barges alongside are secured to meet existing weather conditions. Small boats will be operated with caution and loads reduced. Use only LCM and larger types when possible. Boat officers and adequate life jackets will be provided. Commanding officers of ships in the stream in granting liberty should give consideration to the possibility that increasing inclemency in weather could result in the cancellation of all small boating. When the small craft warning is hauled down, SOPA (ADMIN) will cancel the foregoing message.

5. Typhoon Conditions of Readiness Defined.

a. Typhoon Condition of Readiness IV. Typhoon Winds are possible within 72 hours. This condition is to be set each year without further orders from 1 June until 30 November and will be ordered at other times when a typhoon occurs.

b. Typhoon Condition of Readiness III. Sustained winds of fifty knots or more and/or gusts of sixty-five knots are probable within forty-eight hours. Even though the wind velocity mentioned above may not be forecast by the current typhoon advisory, this condition of readiness may be set when evaluation of all factors indicates the desirability of taking certain precautionary measures within Sasebo harbor.

c. Typhoon Condition of Readiness II. Sustained winds of fifty knots or more and/or gusts to sixty-five knots are probable within twenty-four hours.

d. Typhoon Condition of Readiness I. Sustained winds of fifty knots or more and/or gusts to sixty-five knots are probable within twelve hours.

6. Action Required of All Ships.

a. Typhoon Condition of Readiness IV.

(1) Be prepared to take action required under higher conditions of readiness.

b. Typhoon Condition of Readiness III.

(1) Set a continuous watch on the harbor warning net, if not already set.

(2) All ships fuel or ballast as practicable for maximum stability.

(3) Ships disabled, due to overhaul of machinery or upkeep, immediately commence to put engineering plant in operational condition and make the ship seaworthy. Ensure reports required by this Annex have been made.

(4) Towing and Salvage types remain in a readiness condition to assist other ships as may be required.

(5) All commanding officers, unit commanders, and Commander Fleet Activities, Sasebo will normally be directed to attend a typhoon conference during the early stages of Condition III. The following information will be required of each commanding officer attending:

(a) Ability to get underway.

(b) Per cent of fuel capacity aboard.

(c) Material deficiencies affecting capability, if any.

(d) Ships in India Basin may be ordered to proceed to assigned typhoon moorings.

c. Typhoon Condition of Readiness II.

(1) Set a continuous watch on fleet common net, in addition to harbor warning net.

(2) SOPA Sasebo will assume net control of harbor warning net and fleet common net.

(3) Suspend liberty and recall liberty parties.

(4) Secure topsides and set appropriate watertight integrity condition decks.

(5) Raise steam and be prepared to get underway on four hours notice, or as ordered. Ships not able to get underway within four hours report by message to COMFLEACTS, Sasebo.

(6) Break up nest and proceed to berths assigned by COMFLEACTS, Sasebo. Whenever possible, ships will be moved to individual buoys or at least not more than two (2) DD or smaller to a buoy. Sides of all tenders will be cleared.

(7) If alongside piers, put out extra hawsers and tend lines to allow for changes in the height of the water. If practicable, lead anchor chain out and secure it to shore.

(8) Hoist in all small boats not required for essential boating. Small boats which cannot be accommodated aboard will be sent to FLEACTS, Sasebo for shelter. Return all FLEACTS craft unless urgently required.

(9) Proceed to berth and buoy assignments as assigned by COMFLEACTS, Sasebo.

(10) Towing and Salvage types remain in a readiness condition to assist other ships as may be required.

d. Typhoon Condition of Readiness I.

(1) SOPA Sasebo will conduct radio checks every half hour on the harbor warning net and the fleet common net with all ships and stations on these circuits. SOPA will also conduct radio checks every half hour on the tug circuit.

(2) Expedite the completion of requirements of Conditions III and II if not already accomplished.

(3) Station the special sea and anchor details and steaming watches. Be ready to sortie if directed by SOPA.

(4) Execute heavy weather bills. Take additional precautions as deemed necessary such as steaming to anchor or buoy.

(5) It has been found helpful for ships riding at anchor or moored to a buoy during a storm to station an experienced officer in the eyes of the ship where he can advise the bridge as to the proper orders to the engine room to minimize surging against the chain.

7. Action required by Commander Fleet Activities, Sasebo.

a. Typhoon Condition of Readiness IV.

(1) Be prepared to implement action required under higher conditions of readiness.

b. Typhoon Condition of Readiness III.

(1) Prepare shore and harbor installations for the storm. Make preparations to evacuate non-essential personnel to safe areas or shelters.

(2) Report to SOPA any unusual characteristics of merchant ships present which tend to impair their heavy weather seaworthiness (underway, berthed, or buoyed).

(3) Assign the mooring buoys and anchorages to be used by ships present and capable of maneuvering if Condition II is set. Particular attention is directed to consideration of safe scope and swinging radius and capability of buoy moorings to resist dragging. Utilize to the maximum extent Navy controlled drydocks for small boats, service craft

and vessels not able to maneuver or which are unseaworthy. Commanding officers utilizing Navy controlled drydocks for their small craft shall provide crews for these craft who will be responsible for maintaining a watch on the craft while in drydock. Final responsibility for the small craft rests with the commanding officer, since there are normally many craft berthed in the drydock and only a small number of shore based personnel are present at the drydocks. Insofar as practicable, commanding officers' desires concerning assignment to buoy or anchorage will be solicited. Buoy, anchorage, and berth assignments will be promulgated in a single message addressed to all ships present, information to SOPA, and all afloat commanders present. Late arrivals will be assigned individually, by message, information to SOPA.

(4) Alert harbor tugs for employment in assisting ships as required and be prepared to assist in returning liberty parties.

c. Typhoon Condition of Readiness II.

(1) Complete shore and harbor preparations commenced under Condition III.

(2) Assist ships in shifting berths as necessary.

(3) Be prepared to berth and mess small boat crews and liberty parties unable to return to their ships.

(4) Instruct the Provost Marshal and Senior Shore Patrol Officer to direct personnel on shore leave or liberty to report immediately to Fleet Activities, Personnel Office when unable to return to their own command.

d. Typhoon Condition of Readiness I.

(1) Expedite completion of the requirements of Conditions III and II if not already accomplished.

(2) Prepare for disaster conditions.

(3) Report to SOPA the accomplishment of the requirements of these conditions of readiness by merchant ships present.

(4) Station larger tugs at appropriate places in the harbor to assist ships in need thereof.

8. Typhoon Warning and Weather Advisories. Typhoon and tropical storm warnings are broadcast with immediate precedence on all U.S. Navy circuits guarded by Navy ships. Refer to Radio Weather Aids, Volume I, Section 4, for routine weather information.

9. Merchant Shipping Present. Commander Fleet Activities will keep all merchant ships advised of typhoon bulletins and of the setting of typhoon conditions of readiness. He will require that they take adequate precautions commensurate with the condition set. In particular, merchant ships will be required to maintain sufficient personnel aboard to raise steam, veer chain and take appropriate safety measures. He will advise them if the Navy ships will sortie and ascertain the intentions of the merchantmen as to sortie.

10. Reports Required.

a. When a Typhoon Condition of Readiness is ordered for Sasebo, COMFLEACTS shall advise COMNAVFORJAPAN, information to SOPA, COMSEVENTHFLT and the operational commander of ships present, by immediate message of:

(1) Names of all U.S. Navy ships in port capable of maneuvering at sea.

(2) Names of all U.S. Navy ships in port not capable of maneuvering at sea.

(3) Names of all other ships, including merchant ships, in port.

b. Critical Area Reports. Whenever storm conditions exist or are forecast, a CRITICAL AREA is established in the storm area by the cognizant Area Commander. This area is established to obtain information regarding the status of ships within it, and to obtain weather reports not otherwise available. Ships within this area shall report position, course, speed and weater in accordance with COMSEVENTHFLT OPORD 201-YR Annex W., and as may be modified by the CRITICAL AREA MESSAGE. COMSEVENTHFLT and other interested commands will be included as information addressees.

11. Sample Messages - Typhoon Conditions of Readiness.

a. Typhoon Condition III.

(1) PRIORITY

UNCLAS

FROM: SOPA SASEBO, JAPAN
TO: (SHIPS PRESENT BY NAME) SASEBO JAPAN
INFO: COMFLEACTS, SASEBO, JAPAN
COMNAVFORJAPAN, YOKOSUKA, JAPAN
COMSEVENTHFLT

SET TYPHOON CONDITION OF READINESS THREE FOR SASEBO HARBOR AREA, ANNEX W SOPA INST REFERS.

BT

(2) PRIORITY

UNCLAS

FROM: SOPA SASEBO, JAPAN
TO: (SHIPS PRESENT BY NAME) SASEBO JAPAN
INFO: COMSEVENTHFLT
COMNAVFORJAPAN

TYPHOON SORTIE PLAN

A. SOPA SASEBOINST 5000.1 (SERIES)

1. THIS IS SOPA SASEBO EMERGENCY TYPHOON SORTIE PLAN.

2. COMPOSITION, COMMANDER EVASION GROUP AND CTG 96.6

IS ______ IN ______. TASK UNIT ORGANIZATION AS FOLLOWS:

A.
B.
C.
D.

3. INSTRUCTIONS TG 96.6 WILL SORTIE WHEN DIRECTED. SHIPS UNABLE TO SORTIE WILL SHIFT TO SECURE BERTHS, AS DIRECTED BY COMFLEACTS, SASEBO.

4. COMMUNICATIONS. IAW REF A.
BT

(3) SOPA will display the following signal indicating Typhoon Condition III: "Code Emergency THREE".

b. Typhoon Condition II.

(1) SOPA Sasebo will transmit messages similar to the following:

(a) PRIORITY

UNCLAS

FROM: SOPA SASEBO, JAPAN
TO: (SHIPS PRESENT BY NAME) SASEBO JAPAN
INFO: COMFLEACTS, SASEBO, JAPAN
COMNAVFORJAPAN
COMSEVENTHFLT

SET TYPHOON CONDITION OF READINESS TWO FOR SASEBO HARBOR AREA.

(2) SOPA will display the following signal indication Typhoon Condition II: "Code Emergency TWO".

c. Typhoon Condition I.

(1) SOPA Sasebo will transmit a message similar to the following:

(a) IMMEDIATE

UNCLAS

FROM: SOPA SASEBO, JAPAN
TO: (SHIPS PRESENT BY NAME) SASEBO, JAPAN
INFO: COMFLEACTS SASEBO JAPAN
COMNAVFORJAPAN
COMSEVENTHFLT

SET TYPHOON CONDITION OF READINESS ONE FOR SASEBO HARBOR AREA.

(b) SOPA will display the following signal indicating Typhoon Condition I: "Code Emergency ONE".

d. When Typhoon danger has passed and Condition Readiness can be relaxed SOPA will transmit a message similar to the following:

(1) ROUTINE

UNCLAS

FROM: SOPA SASEBO, JAPAN
TO: (SHIPS PRESENT BY NAME) SASEBO JAPAN
INFO: COMSEVENTHFLT
COMNAVFORJAPAN
COMFLEACTS SASEBO JAPAN

SET TYPHOON CONDITION OF READINESS FOUR FOR SASEBO HARBOR AREA. CANCEL EMERGENCY SORTIE PLAN.

BT

APPENDIX D

SHIPS SPEED VS. WIND AND SEA STATE CHARTS

Figures D-1 and D-2 represent the estimated resultant speed-of-advance of a ship in a given sea condition. The original relationships were based on data of speed versus sea state obtained from studies of many ships by James, 1957. They should not be regarded as truly representative of any particular ship (Nagle, 1972).

For example, from Figure D-1, for a ship making 15 kt encountering waves of 16 ft approaching 030° (relative to the ship's heading) one can expect the speed-of-advance to be slowed to about 9 kt. Twenty foot seas, under the same conditon, would result in a speed-of-advance of slightly less than 6 kt. However, it is emphasized that these figures are averages and the true values will vary slightly from ship to ship.

Figure D-3 shows the engine speed required to offset selected wind velocities for various ship types (computed for normal loading conditions).

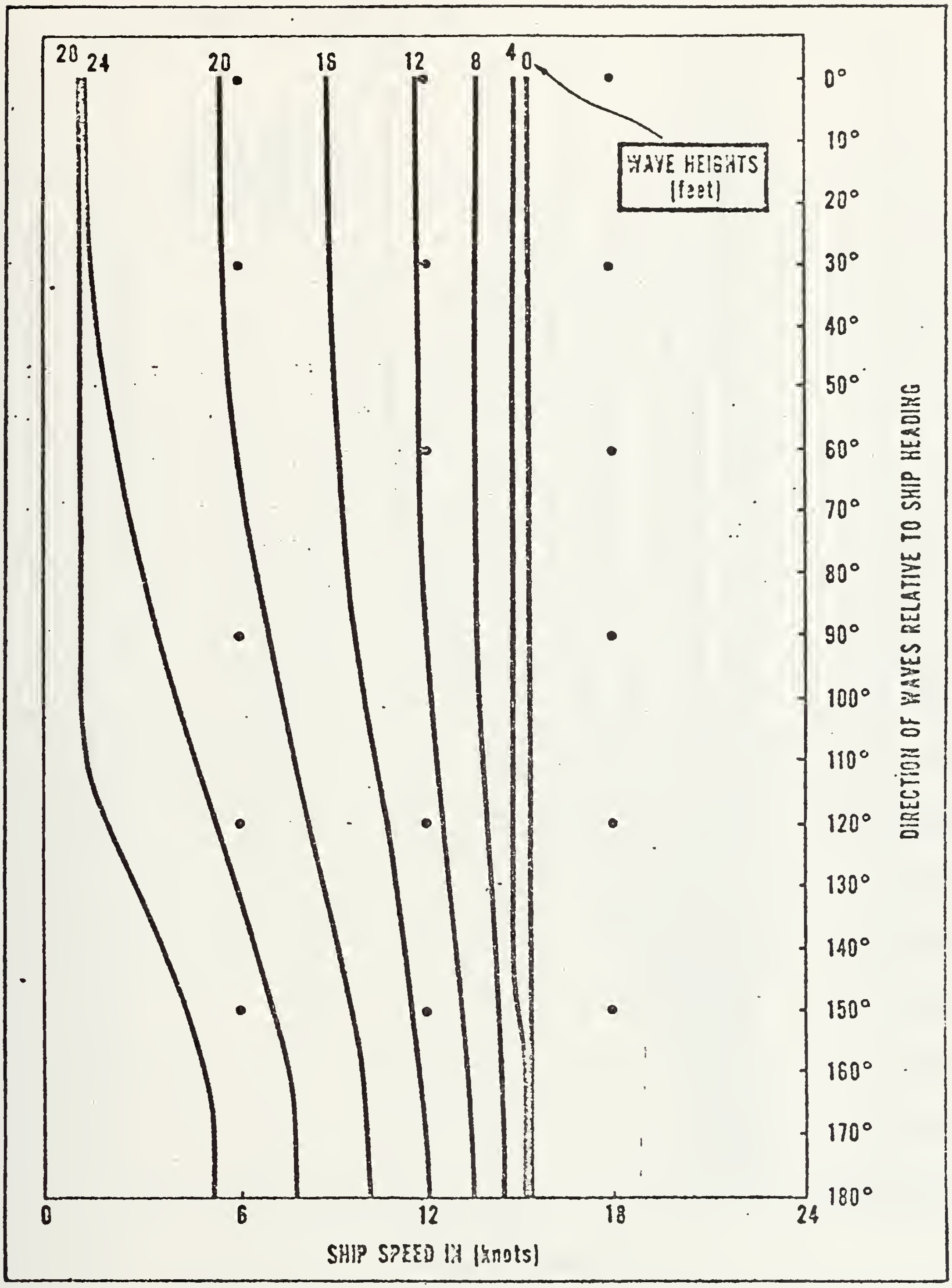

Figure D-1. Ship speed as a function of wave height and wave direction relative to ship's heading (15-kt ship). (From Nagle, 1972.)

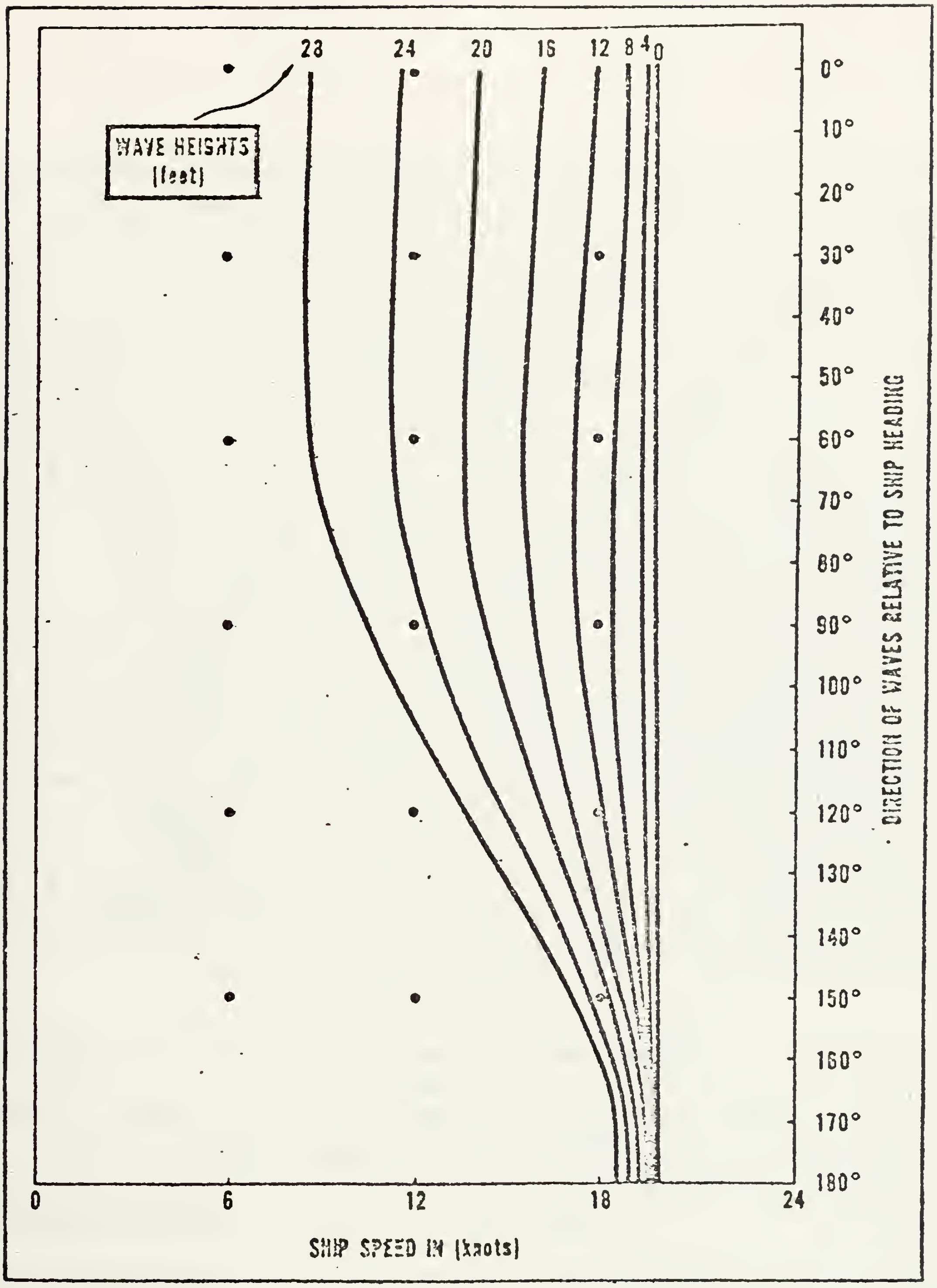

Figure D-2. Ship speed as a function of wave height and wave direction relative to ship's heading (20 kt ship). (From Nagle, 1972)

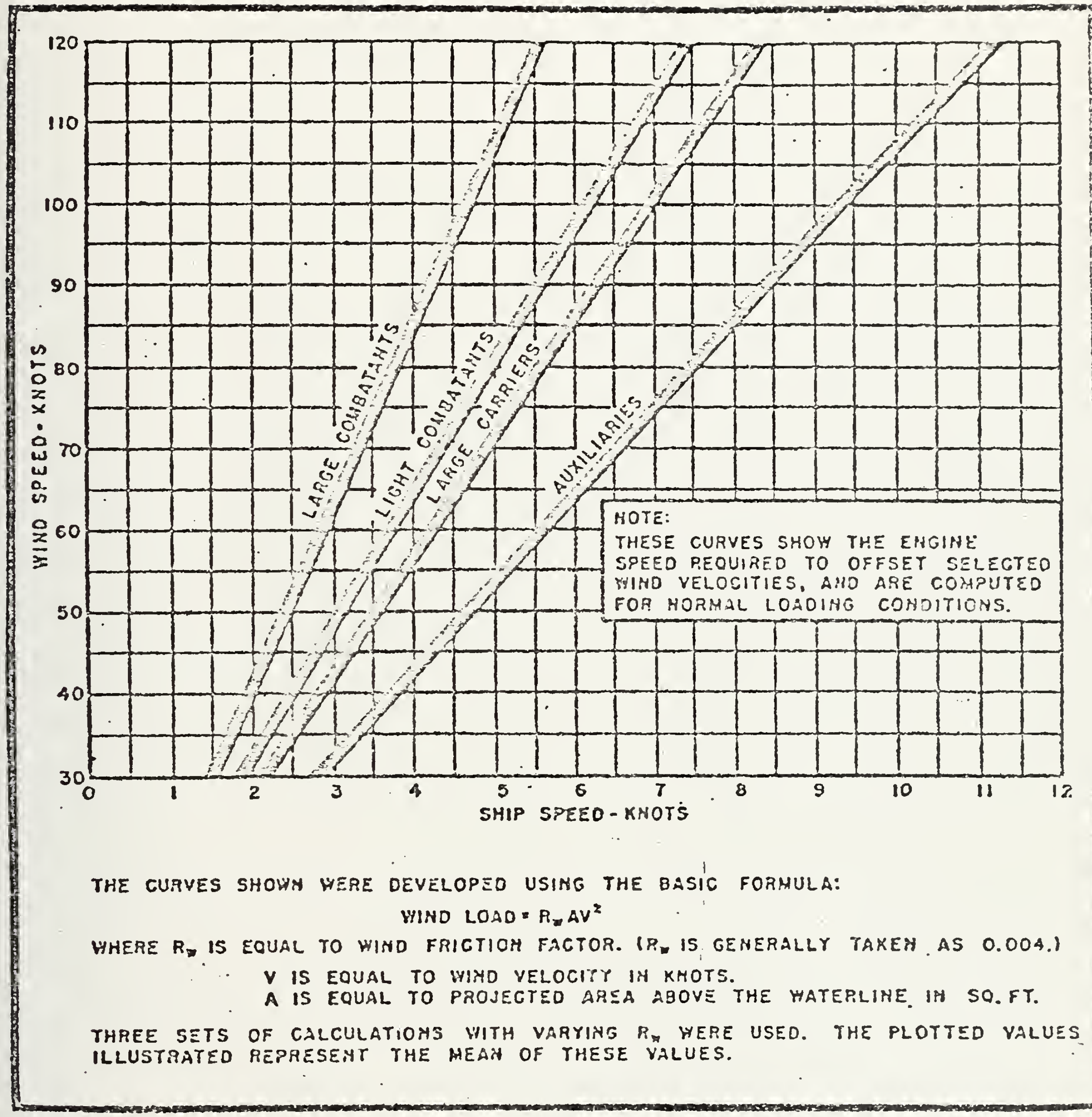

Figure D-3. Engine speed vs. wind velocity for offsetting force of wind. (From Crenshaw, 1965.)

APPENDIX E

Case studies on Typhoon Bess (9 Aug 1963), Typhoon Olive (5 August 1971) and Typhoon Gilda (6 July 1974).

Typhoon Bess (9 August 1963).

a. Narrative:

On 27 July 1963 at 06Z, warning number one was issued by FWC/JTWC, Guam, on Tropical Depression #20, located about 75 n mi southwest of Guam with maximum winds of 25 kt (See Figure E-1 for Best Track of Typhoon Bess). After moving northward to a position about 200 n mi northwest of Saipan it was upgraded to become Typhoon Bess on 30 July at 00Z. Bess followed an unusual path for the next five days, first heading northward, then westward, then towards the southwest, west and finally northwest. By 00Z on 4 August, with 90 kt of wind near the center, Typhoon Bess started to follow a sinusoidal path toward Kyushu. In its transit toward southern Japan, the storm attained maximum winds up to 130 kt. At 03Z on 9 August, the center of Typhoon Bess moved inland near Nobeoka on the east coast of Kyushu with center winds of 100 kt. As it crossed the land area, Typhoon Bess decreased in intensity and was downgraded to a tropical storm at 12Z on 9 August with maximum sustained winds of 60 kt. Bess moved along the northeastern side of the island of Kyushu, and was located near Fukuoka on the southern part of the Sea of Japan at about 16Z on 9 August.

This storm passed approximately 65 n mi to the northeast of Sasebo at CPA. The maximum hourly wind recorded by a meteorological unit at Sasebo during the passage was 38 kt; the maximum gust registered was 61 kt. There were

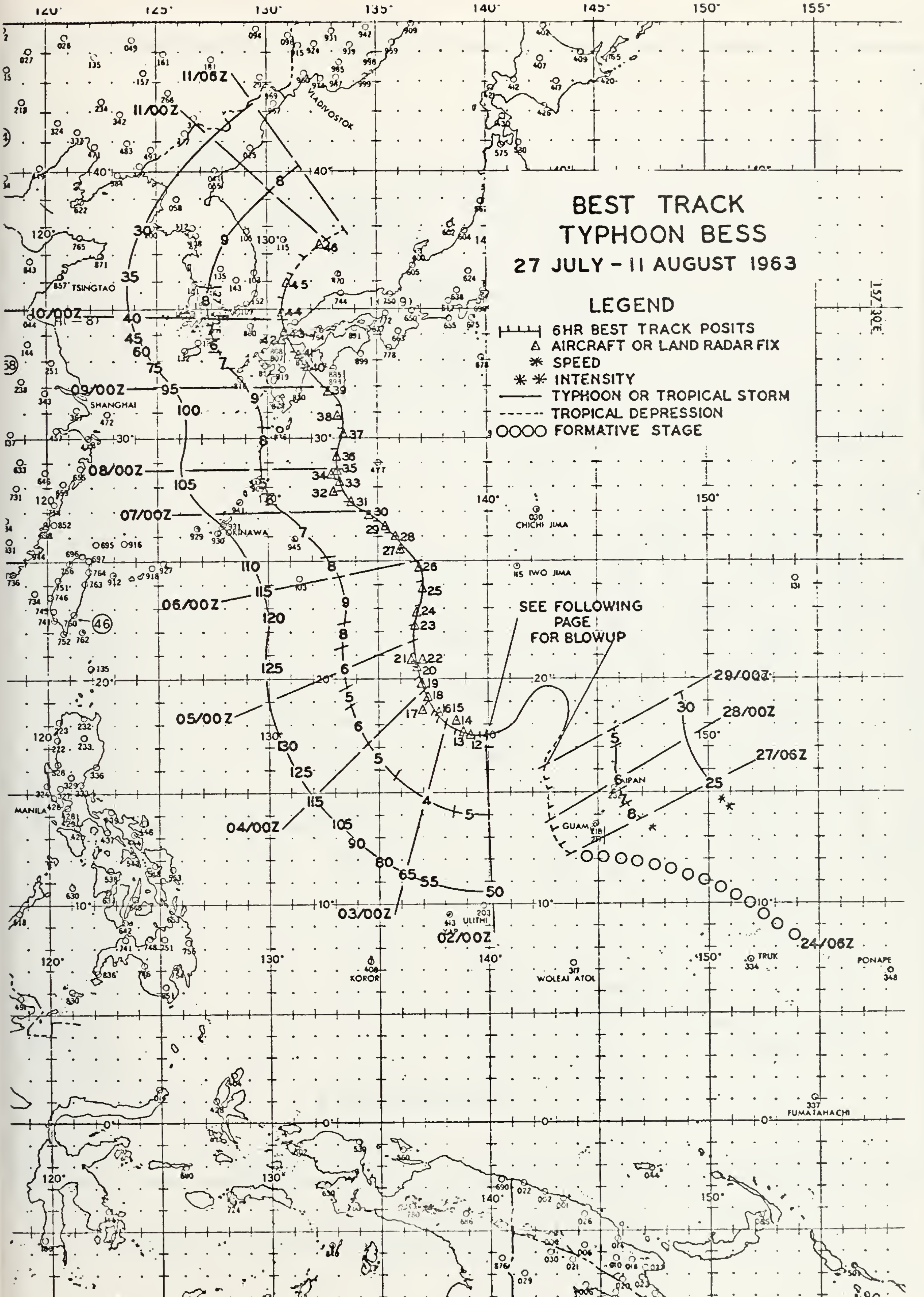

Figure E-1. Best track of Typhoon Bess.

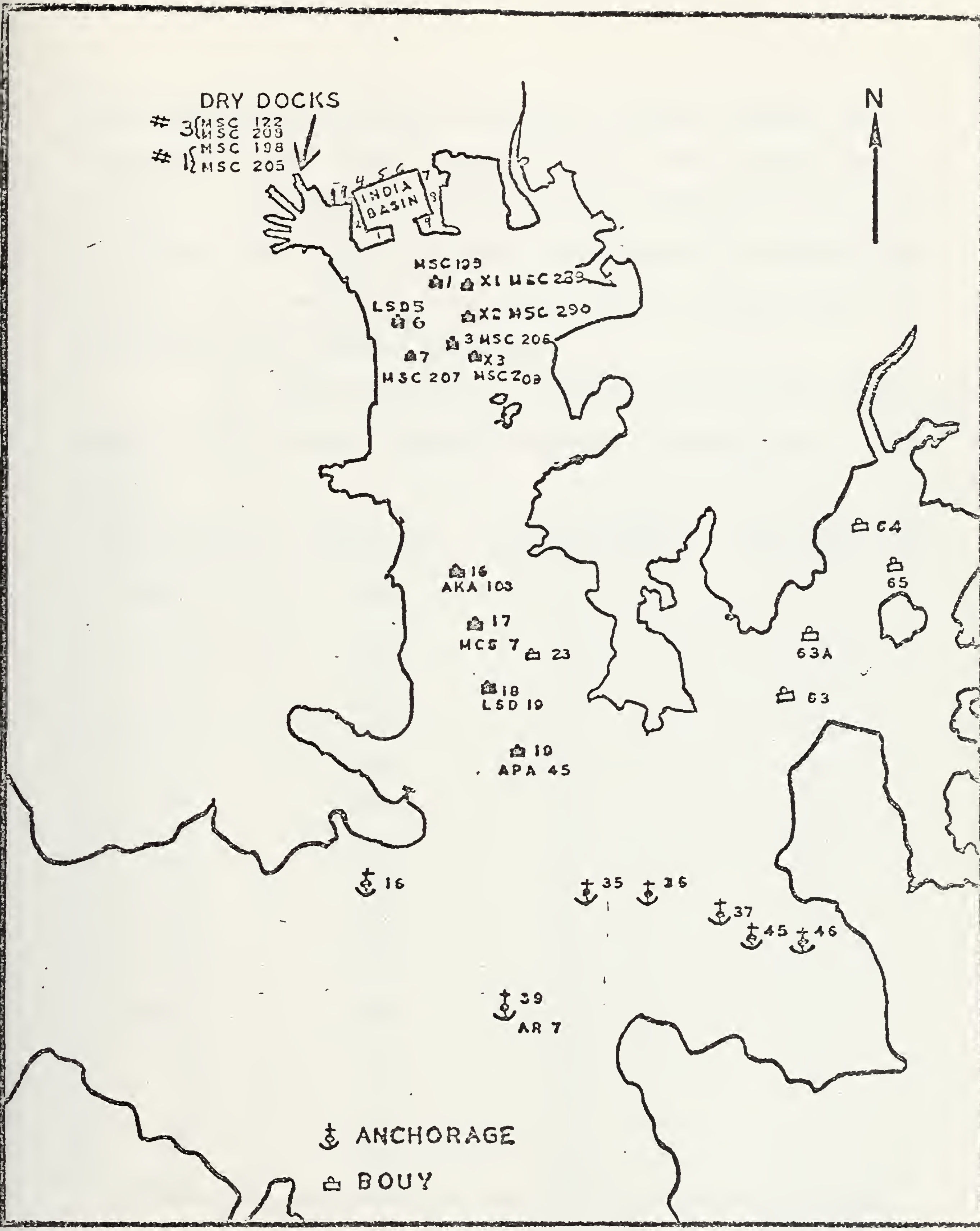

Figure E-2. Berthing diagram of U.S. naval vessels in Sasebo Harbor during the passage of Typhoon Bess.

16 commissioned U.S. naval vessels at Sasebo during the passage of this storm, ranging in size from Coastal Minesweeper to Repair Ship. Their berthing diagram is indicated in Figure E-2. Four minecraft were berthed in wet drydocks; eleven ships were moored to buoys, and the Repair Ship was located at the typhoon anchorage.

b. Winds recorded at Japanese Maritime Self-Defense Force Office, Sasebo, during passage of Typhoon Bess, August 1963:

DAY/TIME (Z)	DIRECTION	VELOCITY (KT)	PEAK GUST (KT)
08/12	NNE	20	32
13	NNE	20	36
14	NNE	22	40
15	NNE	20	38
16	NNE	18	26
17	NNE	22	40
18	NNE	18	30
19	NNE	18	22
20	NNE	18	30
21	NNE	20	36
22	NNE	16	22
23	N	28	42
09/00	NNE	20	42
01	N	26	43
02	N	28	50
03	N	30	48
04	N	30	50
08/05	N	38	61 Max Velocity & Gust
06	N	32	52
07	N	36	52

DAY/TIME (Z)	DIRECTION	VELOCITY (KT)	PEAK GUST (KT)
08/08	N	24	48
09	N	20	44
10	N	20	40
11	NNW	20	34
12	N	20	38

c. Comments by personnel and units involved:

(1) Reports from ships:

SHIP	BERTH	REMARKS
ALBATROSS (MSC-289)	Buoy X-1	Satisfactory for MSC type although wet drydock more suitable.
COMSTOCK (LSD-19)	Buoy 18	Berth adequate.
COMORANT (MSC-122)	Drydock 3	Drydock number 3 highly favorable. Problems none. Very safe typhoon berth.
GUNSTON HALL (LSD-5)	Buoy 6	No problem experienced. Berth considered suitable during typhoon.
EPPING FOREST (MCS-7)	Buoy 17	No problems. Berth satisfactory.
GANNET (MSC-290)	Buoy X-2	Satisfactory.
HECTOR (AR-7)	Anchorage 39	Anchored in 15 fathoms. With 105 fathoms to port anchor. Severe yawing encountered in winds over 40 knots. Require additional anchor under foot. Berth adequate.
HENRICO (APA-45)	Buoy 19	No problems experienced at Buoy 19. Anchor dropped to reduce yaw and steam used on occasions to reduce strain on chain. Consider berth highly satisfactory.
PEACOCK (MSC-198)	Drydock 1	No problems. Berth excellent.

SHIP	BERTH	REMARKS
PHOEBE (MSC-199)	Buoy 1	Assigned berth satisfactory and suitable for typhoon. Experienced great deal of yaw despite use of rudder and anchor underfoot. Consider this inherent in MSC type vessels.
VIREO (MSC-205)	Drydock 1	Wet dock - no problems. Stability excellent. Highly recommended for MSC typhoon berth.
WARBLER (MSC-206)	Buoy 3	At mooring buoy 3 with 45 fathoms of chain to the buoy, placed ships stern within 50 yards of the MINOIRISE buoy during high winds.
WASHBURN (AKA-108)	Buoy 16	Buoy 16 considered suitable typhoon berth utilizing anchor underfoot to prevent yawing and steaming to buoy as necessary to ease strain on buoy mooring.
WHIPPOORWILL (MSC-207)	Buoy 7	Utilized 60 fathoms of chain to Buoy 7 with anchor underfoot to 12 fathoms at height of storm. Biggest problem yawing 80 degrees either side of wind. Anchor reduced yawing slightly. Less than 60 fathoms of chain to buoy caused excessive strain as chain cleared water. Buoy 7 satisfactory for typhoon but seemed to experience more wind than other MSC mooring.
WIDGEON (MSC-208)	Drydock 3	Drydock 3 highly favorable. Problems none. Very safe typhoon berth.
WOODPECKER (MSC-209)	Buoy X-3	Mooring satisfactory, suitability questionable due to location.

(2) Comments by Operations Officer, Fleet Activities, Sasebo:

"Throughout the period of transit of Bess, our Operations Department was manned continuously and repeated wind observations were noted on our anemometer. With the exception of one short gust to 47 kt in the morning, the average winds were 30-35 kt and could not be considered of typhoon velocity."

"By virtue of the fact that Bess passed to our East, we were exposed to North and Northeasterly winds as it approached. This fact also worked in our favor as the harbor is sheltered on the North by a range of hills extending to 2000 ft in height."

d. Conclusions:

The following conclusions can be reached from this case study:

1. All U.S. naval vessels considered Sasebo Harbor as a safe typhoon haven during Typhoon Bess' passage east of Sasebo. No damage was reported by any of these ships.
2. Winds reported by ships in the harbor tended to be higher than those reported by land based units (maximum of 48). Ships in the southern part of the harbor at typhoon anchorage reported winds near the maximum, while ships in the northern part of the harbor reported winds close to 40 kt.
3. The use of a second anchor dropped under foot to reduce yawing, in addition to steaming to

the anchor/mooring buoy to reduce the strain on the chain are highly recommended.

4. The wet drydocks provide excellent shelter for smaller ships.

Typhoon Olive (5 August 1971)

a. Narrative

Olive climaxed the most active July on record as another in a succession of circulations in the equatorial trough formed east of Guam on 24 July. After drifting over Guam the system took a northward bend due to the influence of a weak trough to the north. After commencing a northeast drift, the circulation began to grow in size but did not become better organized. By the 29th a rather complex cloud system was in evidence as viewed by satellite. As the subtropical ridge began to strengthen, the depression began to slowly intensify and start an erratic, meandering westerly track, reaching storm status early on the 31st. Switching to a northwest direction, Tropical Storm Olive finally achieved typhoon force by mid-day of the 2nd. The typhoon reached her peak intensity of 85 kt some 48 hours later as she neared Yaku-Shima in the northern Ryukyus (Refer to Figure E-5 for best track).

With the approach of a long-wave trough off the coast of China, Typhoon Olive swung to a northerly track with her center driving through western Kyushu east of Nagasaki on the 5th. Crossing the Ryukyus, the highest winds and lowest pressure were reported at the Japanese Yaku-Shima station with 80 kt gusting to 119 kt and 938.7 mb respectively.

Torrential rains measuring up to 59.8 inches in the mountainous regions of Kyushu (Ebino, Miyazaki prefecture) accounted for numerous landslides and for 69 persons killed, 209 injured, and over 1,700 dwellings partly or completely destroyed. At sea the 7,935-ton motorship KAMO MARU was forced aground off Hesaki Lighthouse while the 975-ton SHINMEI MARU ran aground six miles west of Anami-o-shima.

Weakened considerably by her traverse of Kyushu, Typhoon Olive entered the Sea of Japan as a tropical storm and paralleled the Korean coast before turning on a northeast coast and becoming extratropical.

b. Comments by Commanding Officer, USS AJAX (AR6).

USS AJAX (AR6) was moored to berth India 8 at India Basin with standard mooring lines doubled fore and aft with a wire forward and hawser aft. The ship was in a "Cold Iron" status on four hour notice for getting underway and in a C-1 equipment readiness status. At 031235I Typhoon Condition III was set in Sasebo Harbor in preparation for the typhoon. AJAX ran out an extra wire forward and hawser aft at 032230I. Wind conditions during the period and for the next 36 hours remained relatively normal although the sky became progressively clouded as the storm moved north over Kyushu. At 050010I AJAX lighted fires under boilers #1 and #2 to increase the ship's readiness for getting underway to 30 minute standby. At 050440Z AJAX lighted fires under boilers #3 and #4. Wind strength was steady at 5 kt throughout India Basin

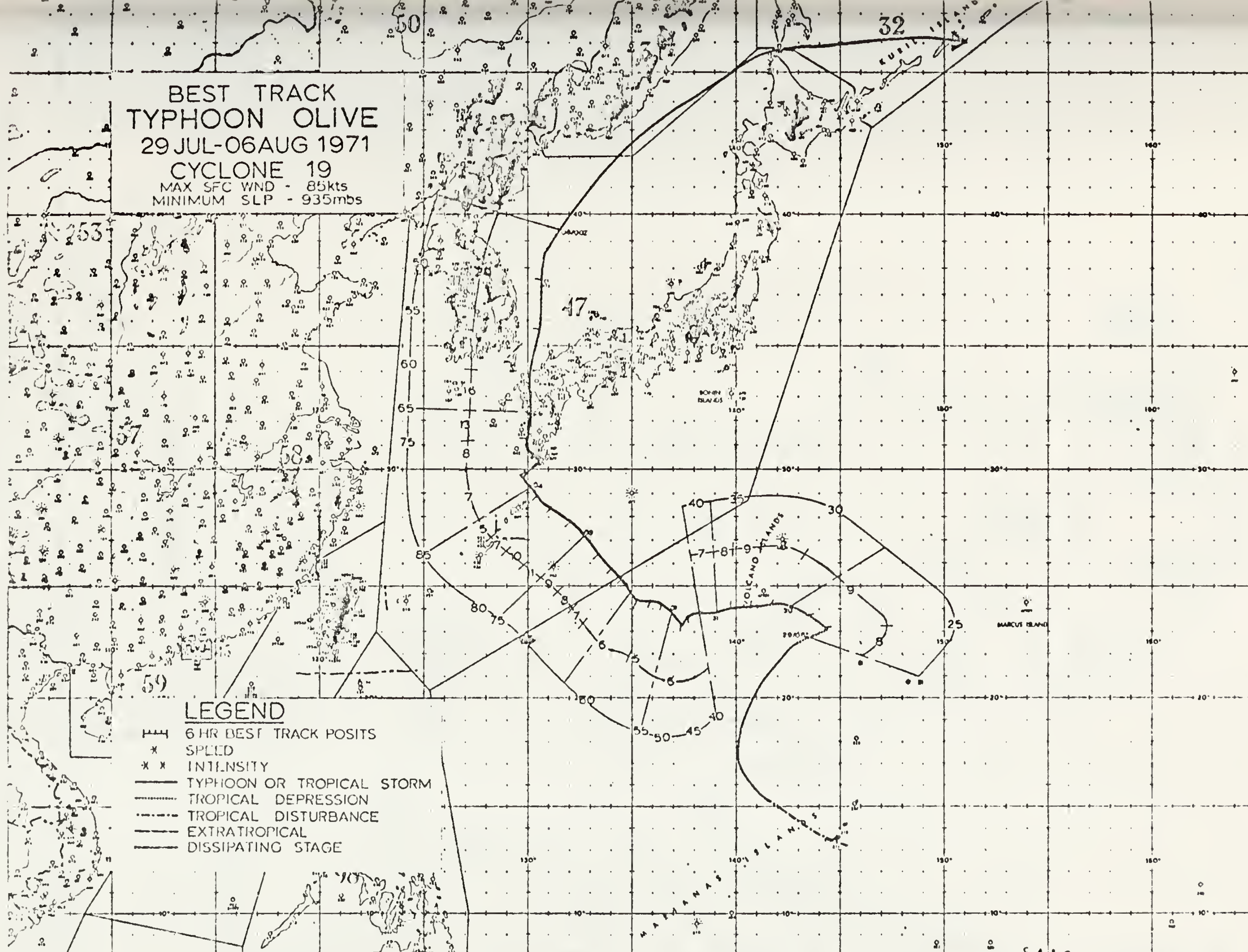

Figure E-3. Best Track of Typhoon Olive.

Figure E-4. Berthing diagram of U.S. naval vessels in Sasebo Harbor during the passage of Typhoon Olive.

with occasional gusts to 8 kt. Wind direction steadied at approximately 010 degrees (T) with the sky nearly completely overcast. AJAX stationed the special sea and anchor details in preparation for getting underway for anchorage.

At 20Z 4 August, Typhoon Condition II was set in Sasebo Harbor. By 2030Z Typhoon Condition I had been set with those naval ships in India Basin moving out to anchorage. AJAX got underway at 2250Z for anchorage 35 in Sasebo Wan. The sky remained overcast with broken clouds. Rain threatened although it held off until later in the day. The ship was in DEFCON Four throughout the entire period Typhoon Olive passed over Kyushu. The AJAX diving boat was sent to FLTACTS Sasebo boat pool to ride out the storm. This lessened the topside weight and sail area available on AJAX. The ship proceeded smoothly to anchorage 35 Sasebo Wan with pilot assistance and anchored in 10 fathoms of water. Anchorage 35 has a mud bottom and offered good holding properties for the anchor. AJAX used only the stbd anchor with 90 fathoms of chain.

The engineering plant remained on 30 minute standby while at anchor. As Typhoon Olive passed over Kyushu to the east of Sasebo, the storm continued to diminish in strength. The eye of the storm passed by Sasebo at 00Z on 5 August traveling due north at 8 kt with maximum sustained winds at 65 kt. At 03Z Olive passed along the northeastern side of Kyushu near Fukuoka and moved into the Sea of Japan and was downgraded to a tropical storm.

SOPA set Typhoon Condition IV at 06Z on 5 August and AJAX waited for the winds to die down before proceeding back to India Basin. By 09Z the worst of the winds passed and the storm diminished in strength. AJAX remained at anchor throughout the night under clear skies and proceeded to get underway at 2130Z for India Basin. At 2245Z, AJAX moored to berth India 8, India Basin.

This storm passed approximately 50 miles to the east of Sasebo. The maximum hourly wind velocity recorded by AJAX while in anchorage 35 was 43 knots with maximum gust up to 45 knots. Typhoon Condition I was set at 2030Z on 4 August by SOPA. Two other U.S. naval vessels were present in India Basin, the USS DURHAM (LKA-114) in India 6 and the USS TALUGA (AO-62) in India 1. TULUGA was underway at 1930Z on 4 August for Buoy 19. USS QUAPAW (ATF-110) moored in India 9 was the only U.S. naval vessel to ride out the typhoon within India Basin. AJAX rode out the typhoon easily on 90 fathoms of chain. During maximum wind velocity, the strain on the anchor chain was moderate and the ship was not damaged in any way.

Civilian ships belonging to SSK Shipyard moored within India Basin at berths 4 and 5 and on the outer enclosure to India Basin. They rode the storm out from those positions with no apparent damage. The maximum wind within within India Basin at the height of the storm was approximately 25 knots. No damage was reported from any of the U.S. naval

ships and berthing in all cases was considered adequate. It is felt that all U.S. naval ships present could have been protected from Typhoon Olive at their assigned moorings within India Basin.

NOTE: Comments from the commanding officers of the other three U.S. naval vessels in port during Typhoon Olive's passage east of Sasebo are not available.

b. The following Typhoon Olive wind observations were recorded by USS AJAX:

DAY/TIME (Z)	DIRECTION	VELOCITY(KT)	PEAK GUSTS(KT)	
04/21	350°	5	8	
22	000°	10	14	
23	345°	15	18	
05/00	340°	15	18	
01	340°	18	23	
02	320°	22	24	
03	275°	17	24	
04	240°	21	22	
05	232°	25	27	
06	245°	25	28	
07	246°	25	35	
08	240°	43	45	MAX VELOCITY GUST
09	220°	32	40	
10	240°	25	30	
11	215°	18	23	
12	230°	13	--	

c. Conclusions.

The following conclusions can be reached from this case study:

1. Sasebo Harbor was found to be a safe typhoon haven with no problems reported.

2. India Basin could be used to provide shelter for a typhoon passing to the east of Sasebo (See Figure 6b for close-up view of India Basin).

Typhoon Gilda (6 July 1974)

a. Narrative:

On 30 June 1974 at 06Z, warning number one was issued by FWC/JTWC, Guam on tropical depression #9, located about 500 n mi southeast of Okinawa (See Figure E-5). Within 12 hours, tropical depression #9 was upgraded to become Tropical Storm Gilda 560 n mi southeast of Okinawa. Moving slowly westward thereafter, Tropical Storm Gilda was upgraded to Typhoon Gilda at 00Z on 2 July. As a typhoon, Gilda moved slowly to the north into the East China Sea passing 80 n mi west of Okinawa. She reached maximum intensity with central winds of 95 kt at 18Z on 4 July while 390 n mi south-southwest of Sasebo. At 12Z on 6 July Typhoon Gilda reached

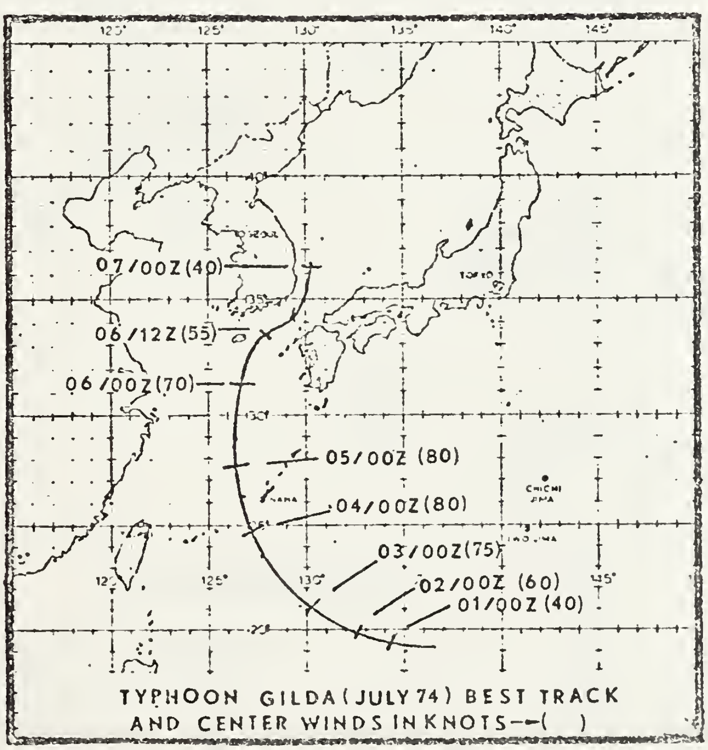

Figure E-5. Best Track of Typhoon Gilda.

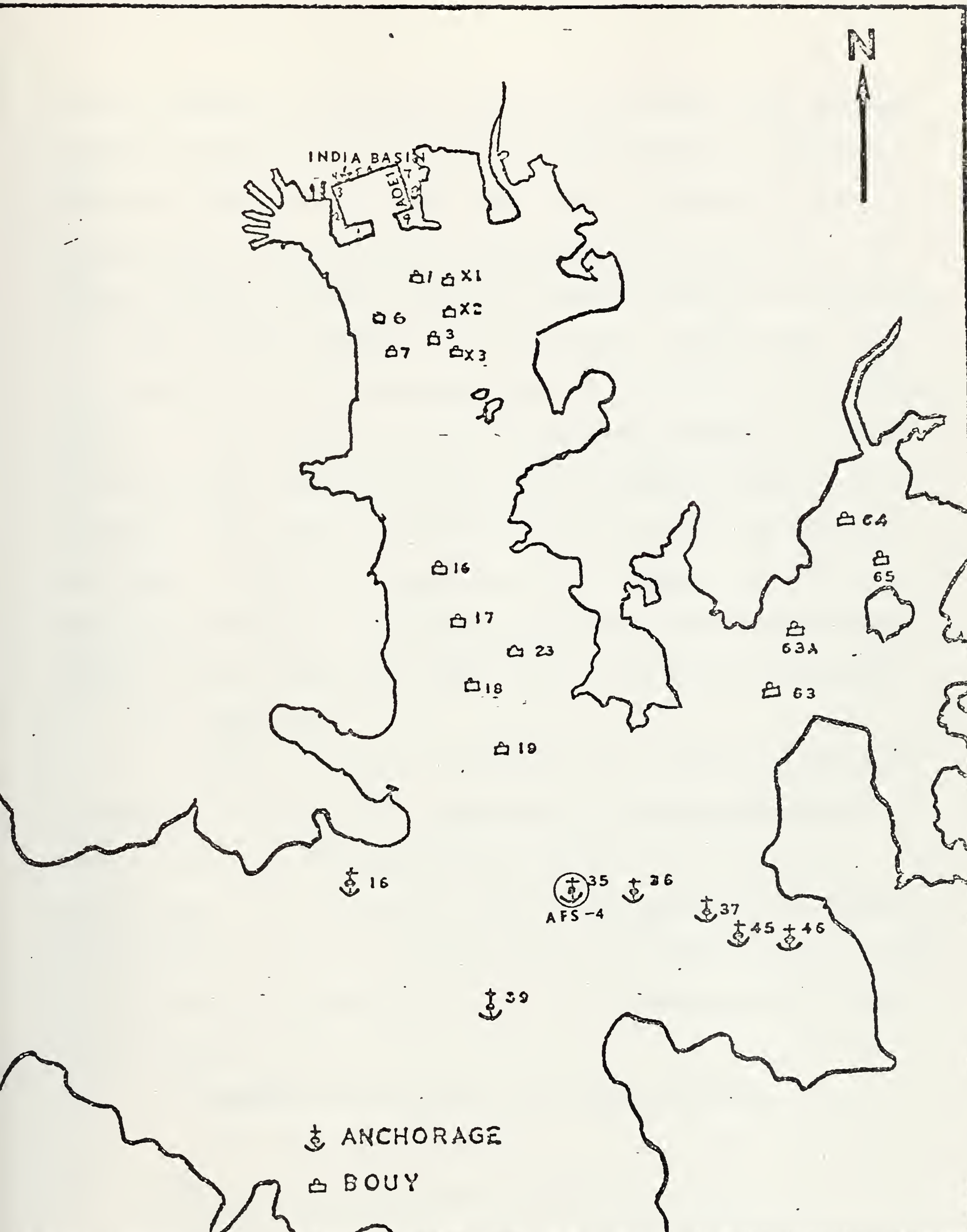

Figure E-6. Berthing diagrams of U.S. Navy vessels in Sasebo Harbor during the passage of Typhoon Gilda.

CPA to Sasebo of 75 n mi to the west-northwest with maximum central winds of 60 kt. She was downgraded to a tropical storm at this point. After CPA, Gilda continued to move toward the north-northeast passing 20 n mi to the west of Pusan, Korea, and into the Sea of Japan where she dissipated. At CPA to Sasebo maximum sustained winds recorded were from the south at 45 kt with maximum gusts of 70 kt in the outer harbor. Two commissioned U.S. naval vessels were in port during Gilda's passage to the west of Sasebo. One was anchored at the typhoon anchorage and the other was berthed at India 7 and 8 (See Figure E-6). No damage was reported by these ships and the typhoon anchorage was reported satisfactory while berths at India 7 and 8 was found to be good.

b. Wind Data:

Wind velocities observed during Gilda's passage are presented in Table E-1. Comparing the Japanese Weather Bureau wind observations to observations taken by other activities, it is apparent that the Japanese Weather Bureau wind observations were considerably less than the rest. This is due to their protected location in relation to the wind direction.

c. Comments by personnel and units involved.

(1) Reports from ships:

Ship: USS WHITE PLAINS (AFS-4)

Berth: Anchorage 35 with 10 fathoms to a mud bottom. Anchored with 120 fathoms to port anchor.

DAY/TIME(Z)	FLEACTS	WHITE PLAINS	SACRAMENTO	JAPANESE WEATHER BUREAU	STORM POSIT	CENTER WINDS
05/19		NE 9		E 9	210 SW	70
21	SE 12	NE 6			205 SW	70
23	E 5	NE 5			185 SW	70
06/00	NE 10-15		E 22	E 11	175 SW	70
01	E 18				170 SW	70
02	E 8				165 SW	70
03	ESE 10				150 SW	65
04	SE 21		SE 30	E 16	140 WSW	65
05	SE 30		SE 24	E 12	125 WSW	65
06	SE 20			E 10	115 WSW	65
07	SSE 25		SE 25 G 32	SE 8	105 WSW	65
08	S 30G 50	SSE 35G45	SE 30 G 40	SE 13	90 WSW	65
09	S 35	S 40 G 50	SSE 40 G 50	SSE 18	85 W	60
10	S 35	SSE 45 G 60		SSE 18	85 W	60
11	S 40	S 45 G 70	S 40 G 63	SSE 18	80 W	60
12	S 40	S 45 G 60	S 40 G 55	SSE 18	75 WNW	60
13	S 45	S 45 G 55	S 30 G 55	SSE 15	75 WNW	60
14	S 35	S 40 G 60	S 35 G 50	S 12	80 NW	60
15	S 30	S 45 G 55		S 12	80 NW	55
16	S 30	S 45 G 50		S 11	80 NW	55
17		S 40 G 50		S 13	90 NNW	55
18	S 30	SSW 30 G 40		SSW 12	95 NNW	55
19		SSW 30 G 45		SSW 11	105 NNW	55
20		SSW 30 G 40		SSW 10	120 N	50
21		SSW 35 G 40		SSW 10	140 N	50
22		SSW 25 G 35		SSW 8	165 N	45

Table E-1. Wind Observations During (in kt) Typhoon GILDA's Passage West of Sasebo

Wind: Max sustained wind 45 kt with gusts to 65 kt 170°-180° between 19Z - 23Z on 6 July with max gusting at 1915Z at 70 kt.

Suitability of Berth: Satisfactory. Elevation of Nishi-Sonogi Peninsula and Hario Island to south served as relatively effective wind break. Condition of sea inside of Kogo-Saki (harbor entrance) noticeably calmer than outside. Mud bottom provided excellent holding ground.

Remarks: Severe yawing experienced with winds over 35 kts. Steamed to the anchor at 3 kts for winds up to 45 kt. Steamed at 6 kt during sustained gusts of 65-70 kt. Used full rudder and 6 to 8 kt to check swing at extremes of yaw excursions during peak gusts. No heavy strain or dragging experienced. Rudder relatively ineffective to prevent yawing. Power bursts at yaw limits with full rudder eased the strain on the anchor. Used surface search, Pathfinder, and fire control Radars to cross check visual fixes in order to detect dragging during periods of reduced visibility in heavy rain. All three radars provided excellent fixes. Steamed two boilers and two ship service generators to have full power available. Because of uncrowded conditions in harbor was able to ride to 120 fathoms with 700 to 1000

yds clearance on all other anchored vessels. All vessels observed experienced considerable yawing during periods of high winds and peak gusts. Used periods when winds between 30 and 45 kts to provide opportunity for OOD's to experience characteristic of ship steaming to anchor to ease strain.

Recommendations: Maintain at least two boilers and two generators on the line to ensure power available to counter high winds and seas and to reduce strain on anchor. Limited visibility can be expected during heavy rain. All operational radars including fire control radar should be utilized to cross check position. Drop second anchor underfoot to reduce yawing.

Remarks: Ref B concerning Sasebo as typhoon haven during Typhoon Gilda found valid (Ref B is the 1967 FWF Yokosuka publication, "Sasebo Harbor as a Typhoon Haven".)

Ship: USS SACRAMENTO (AOE-1)

On 6 July 1974, 0635Z, SACRAMENTO was located inside India Basin (#7) with a light draft of 25 ft Fwd, 31 ft Aft and a 36,000 ton displacement. Several other ships were present in the basin including one super tanker, another ship (Esso tanker) was moored outside the basin opposite to India 1 which afforded her least protection of all ships in the area of the basin. SACRAMENTO experienced very little difficulty during Gilda's passage. The events experienced by SACRAMENTO on 6 July 1974 and weather data obtained follow:

At 1039, the ship shifted from berth India 1 to berth India 7 and 8 in a cold iron status. The move was made with the use of tugs YTM 415, YTB 77 and two LCM's. An additional tug, the Kyushu Maru (SSK WB) with a 2200 HP engine, was called on to assist in the move. The services of Kyushu Maru provided an additional margin of safety as the force of the wind (25 kt) made it difficult to position SACRAMENTO. The direction of the wind was 140 degrees true, which pushed the ship away from Berth 7 and 8. It is believed that a greater amount of difficulty would have been experienced had the move been delayed until afternoon.

Upon arrival at berth 7 and 8, the ship was moored port-side, using a standard mooring with 8" nylon line. In addition, three breast lines (5" nylon) and two springlays (1-7/8") were used. One breast line led from the bow, one

from the fantail, and one from amidship. The springlays were put over from the eye of the ship and from the stern. The mooring proved to be more than satisfactory. The breast lines from the bow and amidships were attached to bollards next to the buildings, which created a hazard to vehicles utilizing the road next to India 7 and 8. The hazard was reduced by having strips of white rags secured to the lines making the lines more visible to warn vehicle traffic away. Wooden barricades were provided by port services as an additional warning.

The ship's head while at India 7 and 8 was 160 degrees true, which initially put the wind off the port bow. This tended to push the bow away from the berth placing more stress on Line One and the bow breast line. However, the buildings located in the vicinity seem to provide some shelter. After the winds increased in velocity and shifted to the starboard bow the seas in the basin increased and became confused. Their height increased to a maximum of about 5 ft. In fact, the only difficulty encountered was the result of the water rushing into the basin and piling up against the basin wall aft of the ship creating a back wash that moved between the ship and the dock. This caused the camels to shift forward and dislodge from between the ship and the dock. The camels were moved back into position by using the cargo winches with wire whips attached to the camel. The winches provided enough pull on the camel so that the

pressure of the camel against the ship and dock slowly moved the ship away from the dock allowing the camels to be slipped back into their proper position.

The maximum wind velocity was observed at 1930 with gusts up to 63 knots. The range in tide was observed and it corresponded with the range computed for the tide tables.

Under the conditions experienced with Gilda, the India Basin is considered to be a safe, adequate haven. Had the ship remained at India 1, it is believed that it would have been more exposed to the southerly winds with a resultant increase of strain on the mooring lines. The increased freeboard and absence of protecting buildings would have compounded the affects of the wind at India 1.

(2) Comments by Operations Officer, Fleet Activities, Sasebo:

"Typhoon Gilda is the first typhoon to pass to the west of Kyushu in more than two years. In the past when reaching the southern tip of Kyushu, typhoons would veer to the northeast or go inland. Effects of these typhoons were minimum as to winds . . . The most noteworthy item about Gilda was the slowdown in her northerly movement as she approached west of Sasebo. She reached her maximum winds at about the time of high tide. This caused large amounts of water to break over seawalls at Tategami and southern walls in both Juliet and India Basin. Due to prior preparations only"

"minor storm damage was experienced in Sasebo Harbor. Sasebo is definitely a safe harbor and typhoon haven."

d. Conclusions:

The following conclusions can be reached from this case study:

1. Both U.S. naval vessels considered Sasebo Harbor as a safe typhoon haven during Typhoon Gilda's passage west of Sasebo.
2. India Basin, berth 8 and 9, can be used as a shelter from a typhoon passing to the west of Sasebo. Figure 6b indicates that some shelter from southerly winds is provided by the building just to the south of berth 9. Maximum seas reported during Gilda's passage were 5' confused.
3. All radars should be used under conditions of restricted visibility to obtain accurate fixes.

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